The Federal Plan for Meteorological Services and Supporting Research

FISCAL YEAR 1968

U. S. DEPARTMENT OF COMMERCE
Environmental Science Services Administration
Office of Federal Coordinator for Meteorological Services and Supporting Research

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FOREWORD

The atmosphere is to human life as the ocean is to marine life. Wherever man goes, whether into space or to the ocean depths, he must carry with him a portion of the atmosphere in which he lives.

Weather, the product of changes constantly occurring in the atmosphere, has affected all life on earth since the beginnings of civilization and has thus influenced the course of history.

Realizing his dependence on weather, man has sought through centuries of study to observe, describe, predict and modify the behavior of the atmosphere.

PREFACE

This Federal Plan is the third to be developed by the Office of the Federal Coordinator for Meteorological Services and Supporting Research. The plan is published annually to provide the Congress and the Executive Branch with a coordinated, overall plan for Government meteorological services and for those research and development programs whose immediate objective is to improve meteorological services. Guidelines are set forth in Bureau of the Budget Circular A–62.

The principal work of coordinating weather activities and of preparing and maintaining the Federal plan is performed by two interagency committees —the Interdepartmental Committee for Meteorological Services and the Interdepartmental Committee for Applied Meteorological Research. Membership is shown on the inside cover of this plan. These committees and their subcommittees conduct systematic, continuous reviews of basic and specialized meteorological requirements, services and supporting research.

This plan covers the programs of all agencies for FY–67 and FY–68. The first section of the plan presents certain milestones since July 1965. This is followed by a summary of the fiscal data. Next the basic and specialized meteorological services are each presented from an operational point of view along with the supporting research programs aimed at improving the individual services. Sections then follow which treat the operational and supporting research programs separately and in terms of the meteorological functions performed, such as observing the weather, transmitting data and preparing forecasts. The final section of the plan contains a special analysis of the meteorological satellite area.

Robert M. White
Federal Coordinator for Meteorological Services and Supporting Research

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Key To Organizations:

ICSC —Interoceanic Canal Studies Commission
NSF —National Science Foundation
HEW —Health, Education and Welfare
AEC —Atomic Energy Commission
FAA —Federal Aviation Agency
NASA —National Aeronautics and Space Administration

MILESTONES IN METEOROLOGY

The initial pages of this plan present the significant highlights that have occurred as a result of efforts to improve meteorological services since the beginning of FY–66.

SATELLITES

In the satellite area, the National Operational Meteorological Satellite System of the Environmental Science Services Administration (ESSA) became a reality in February 1966, with the launching of ESSA 1 and ESSA 2 spacecraft, providing daily global cloud cover observations.

One of the most spectacular and promising events during 1966 was the launch by NASA of the Applications Technology Satellite (ATS). On December 6, 1966, the first Applications Technology Satellite (ATS–1) was placed in a synchronous, stationary orbit of 22,300 miles over the equator above the Pacific Ocean (151 degrees West longitude). The two meteorological experiments associated with this spacecraft are operating successfully. The Spin Scan Camera is providing the first high quality cloud cover pictures taken from an earth-synchronous satellite. These pictures show the disc of the earth with a maximum resolution approaching two miles and cover the total area between 54 degrees latitude north and south. The camera system can take these pictures once every 20 minutes and smaller areas more frequently, thus affording a potential continuous watch of the weather patterns over the globe. The second experiment permits the transmission of weather data (weather maps and cloud analyses) from the ESSA facilities at Suitland, Md., through ground stations and the satellite's VHF transponder to satellite readout stations in the United States, Japan and Australia.

The Air Force procured seven additional transportable weather satellite readout units which can be deployed anywhere in the world on very short notice to support Air Force and Army operations. These units provide direct receipt of weather pictures taken and transmitted during daily passes of the ESSA Automatic Picture Transmission (APT) satellite.

The Navy is developing a meteorological satellite readout station for shipboard use. A system using a tracking antenna was tested on two aircraft carriers. Although the system had some problems with radar frequency interference and automatic tracking of the antenna, usable pictures have been obtained over a period of several months. While the tracking antenna system is under further development, an interim design is being tested using a conical antenna. Other agencies have indicated an interest in this system.

A more detailed discussion of progress in the meteorological satellite area is contained in a separate section of this plan.

ANALYSIS AND FORECASTING

In the area of weather analysis and forecasting, ESSA introduced a new and more complete numerical forecast model into the operational system on June 6, 1966. Physical effects of heating over warm ocean surfaces and cooling over snow fields have been included, as well as a planetary boundary layer which allows a better approximation of frictional and orographic influences in the earth-atmosphere interface. A new data processing system was delivered to ESSA in August 1965 and is now available to accommodate increasing needs for meteorological data and to process incoming and outgoing data on a wide variety of communication circuits. A system for the automatic production of upper air charts became operational in January 1966, which can produce hard copy or facsimile transmissions to Federal weather briefing offices. A complete set of equations for forecasting daily maximum and minimum temperatures has been developed for 120 cities and put in operation. Further, ESSA has established a Tropical Analysis Center as an integral part of the National Hurricane Center at Miami, Florida.

WORLD WEATHER WATCH

One of the most important activities underway in meteorology today is the planning for an international cooperative effort to improve weather analysis and forecasting and to expand atmospheric research programs on a global basis. This program has been approved by the United Nations and responsibility for its implementation rests jointly with the World Meteorological Organization and the International Council for Scientific Unions. Known as the World Weather Program, it promises substantial benefits to the United States and other nations. The program goals are:

(a) Improve the weather services of the nations of the world

(b) Increase the accuracy of weather forecasts

(c) Develop the capability for making long-range forecasts

(d) Explore the feasibility of large-scale climate and weather modification, and

(e) Promote the economic growth and the technological development of emerging nations

Achievement of these goals will improve the dissemination of weather information and the quality of vital national weather services. It will enable the establishment of more effective agricultural, land and water management planning and, ultimately, result in an increase in worldwide food production.

A special office within ESSA has been formed to provide a focal point for planning United States participation in the World Weather Program.

AIRCRAFT RECONNAISSANCE

The Department of Defense makes an important contribution to the Basic Meteorological Service through the aircraft weather reconnaissance programs of the Navy and the Air Force. As a result of the aging of the collection and dissemination equipment in its reconnaissance aircraft, the Navy has pursued a program to modernize its weather reconnaissance aircraft. The newly installed equipment has been evaluated in flight under actual hurricane conditions with excellent results. Improvements include a Doppler radar navigation system, a navigational computer, an improved airborne weather radar, more accurate temperature and pressure probes, an improved radar altimeter and a droppable bathythermograph. The Air Force has initiated a daily weather reconnaissance track over the North Pole between Eielson AFB, Alaska and England. In addition to this flight, the Air Force now flies nine other daily tracks and averages nearly one million nautical miles of routine weather reconnaissance each month.

SEVERE STORM DETECTION AND WARNING

During the development of the nationwide Natural Disaster Warning System plan by ESSA, it became evident that the existing system for detection of severe local storms was seriously deficient in many parts of the United States. Since weather radar is an essential observing tool in the detection of severe local storms, emphasis upon the development of its capability was a logical recommendation of that planning study. As an outgrowth of the requirement so identified, a radar attachment has been developed by ESSA which greatly increases the speed and accuracy with which radar data can be displayed. The attachment also facilitates automatic processing of weather radar data for rapid automatic transmission of interpretative information. This prototype is in use at ESSA's National Severe Storms Laboratory while engineering effort is underway to provide a version suitable for field operation.

Distribution of weather information, especially severe weather warnings and agricultural bulletins, has been improved in the tornado prone areas of Indiana, Kentucky, Missouri and Southern Illinois by the installation of teletypewriter circuits to the area's radio and TV stations.

COMMUNICATIONS

There is a direct correlation between the quality of a weather service and the adequacy of its supporting communications. The communication of weather data from overseas underwent a marked improvement in July 1965 with the introduction by the Air Force of the Automated Weather Network (AWN) system. Radio-intercept and local teletype weather data are entered into AWN by computer at terminals in Japan and England and transmitted at 3,000 words per minute (wpm) to the U. S. terminal at Tinker AFB where it is retransmitted at speeds up to 4,000 wpm to both military and civil users. Prior to this time, transmission speeds of weather data from overseas was at 100 wpm or less. ESSA's National Meteorological Center is an important beneficiary of this new system. The system has increased surface weather data available to the processing centers by about 25 per cent and upper air weather data by about 33 per cent. There has been an increase of 45 per cent in the number of surface observations available within 1½ hours after observation time and a 67 per cent increase in the number of upper air observations available within three hours after observation time. Delay in the receipt of these data has been a serious problem in the past.

The Federal Aviation Agency (FAA) has produced a new design and specification for the improvement of the civil weather communications circuits A, C, and O. This design features an improved system containing more circuits, each having fewer users than previously. The system incorporates a central switch which controls the circuits and provides for random access storage, modular expansion, high reliability, and collection of message and circuit statistics.

AVIATION

The FAA and ESSA adopted a Memorandum of Agreement, dated August 2, 1965, establishing working arrangements between the two agencies regarding the conduct of aviation meteorological services and supporting research. The agreement in general confirmed existing funding and operating responsibilities and established orderly joint planning procedures.

At the request of the Department of Defense, the Federal Coordinator for Meteorological Services and Supporting Research formed the National Committee for Clear Air Turbulence to study this serious and little-understood problem to civil and military aviation. The committee has completed its work and has recommended a national program for mounting a coordinated attack on clear air turbulence*.

The Runway Visual Range (RVR) System for reporting runway visibility has been improved so as to measure RVR from 1200 to as low as 600 feet. This will provide additional visibility information for the pilot landing under the reduced weather minimums allowed for FAA Category II operations.

**"The Report of the National Committee for Clear Air Turbulence" may be obtained from the Superintendent of Documents, Government Printing Office, at 35 cents per copy.*

The RVR system has been commissioned at an additional 58 civil airports since July 1965 and a program has been initiated for FAA to assume the maintenance and operation of all RVR equipment from ESSA.

The Air Force also has been moving ahead rapidly with the procurement and installation of the RVR system for Air Force bases. This will allow Air Force bases to adopt the FAA system of using RVR for landing minimums during instrument approaches.

The first of 42 planned digital readout displays in Air Traffic Control Towers of conventional altimeter setting indicators has been installed by FAA. The FAA has also prepared a new windspeed and direction digital readout system specification for use in Air Traffic Control towers and Flight Service Stations (FSS).

FSS aviation weather briefings have increased by approximately 50 per cent. To further increase the FSS weather capability, weather facsimile equipment has been installed at an additional 54 FSS's, bringing the total to 67. This provides the FSS with weather maps and charts directly from the National Meteorological Center of ESSA.

The Air Force has developed and procured modern local use weather radars. These sets are being installed at Air Force bases and Army airfields at the present time and will replace obsolete equipment now in use. Many of these Air Force sets will also support nearby ESSA weather facilities through use of remote receiving equipment. Some of these Air Force sets will also fill important voids in the national synoptic network operated by ESSA.

Direct telephone communications were installed between 10 FAA facilities and ESSA weather radar facilities to provide FAA with direct access to a weather radar meteorologist and his equipment. A weather outline contour generator has also been developed by the FAA which will permit storms detected by air traffic radar to be displayed on the enroute air traffic controller's radar scope when the National Airspace System is implemented.

The FAA has also made it easier for aircrew personnel to obtain needed weather information by installing Automatic Terminal Information Service at 32 additional locations for a total of 43, allowing aircrew personnel to receive an automatic in-flight broadcast of terminal information, including terminal weather conditions.

The test of a statistical forcast technique termed Regression Estimate of Event Probabilities (REEP) was completed in March 1966. Since then, forecasts using the REEP technique have been prepared for eight terminals. An evaluation of results is due in early 1967.

The FAA has been conducting comparison tests between airborne weather radar and the ground-based WSR–57 weather radar. Echo patterns were found to be operationally identical, thus substantiating the credibility of airborne weather radar. A much improved airborne weather radar was shown to have twice the detection range of previous equipments. This performance improvement is necessary for newer subsonic and the supersonic aircraft.

GENERAL MILITARY

The military weather services are exerting a major effort in direct support of combat operations in Vietnam. Weather support to military airlift has increased greatly.

Air Force has taken action to obtain and install four long-range weather radars in Thailand and Vietnam. One set, a CPS–9, was drawn from the Air Force inventory while three WSR–57 sets were made available through the cooperation of ESSA. In addition, Air Force obtained and installed seven small weather radars, WTR–1, at major airfields in Southeast Asia for local terminal use. These radars have proven to be outstanding aids to military weather forecasters in this sparse data area.

The Navy has designed a mobile meteorological van for use by the Marine Corps. The van includes all facilities necessary for the acquisition of surface and upper air meteorological observations and for the reception of weather data via radio teletype and radio facsimile. It is planned to include equipment to receive and record APT weather satellite transmissions. Pilots are briefed by closed circuit television on local weather conditions and area forecasts. The van has been tested and evaluated by the Marine Corps in garrison and in the field. The van can perform the functions of a complete weather service office in the field for 30 days or longer.

MARINE

The Navy has reported significant progress in the development of several types of automatic weather stations. An automatic weather station for shipboard use is now undergoing evaluation. The equipment is designed for the remote readout of temperature, pressure, and dew point and will speed the acquisition and increase the accuracy of surface weather observations at sea. Buoy automatic weather stations are undergoing actual environmental testing in the central Gulf of Mexico, in the Atlantic southeast of Halifax and south of Bermuda. New units are currently being manufactured and the Navy plans on-site implementation in summer, 1967. Two polar automatic weather stations have been operating in Antarctica in conjunction with Operation Deepfreeze. One is equipped with a nuclear power generator. An improved polar station is currently being manufactured in-house and should be delivered for evaluation within the next 3 months. Automatic weather stations designed by the Navy for use on tropical islands have been assigned to the Army and have been undergoing environmental testing at two Pacific Island locations.

The Navy has developed and placed into operation a ground-launched meteorological rocket system utilizing chaff and instrumented DARTS. The

chaff provides wind data to approximately 220,000 feet and the instrumented DARTS provide winds and temperatures to approximately 180,000 feet.

VHF FM continuous radio broadcast facilities providing marine weather information are now in operation or are being installed at 19 coastal locations by ESSA. These facilities furnish routine weather forcasts as well as storm warnings for commercial and pleasure boat operators.

Recently, the Navy completed and published "The U. S. Navy Marine Climatic Atlas of the World, Volume VII, Antarctica" (NAVWEPS PUB 50–1C–50).

AGRICULTURE

The Federal Coordinator for Meteorological Services and Supporting Research is currently publishing a Federal Plan for a National Agricultural Weather Service. This plan was prepared by ESSA (Weather Bureau) in cooperation with the Department of Agriculture.

Since July 1965, specialized agricultural weather services have been established in Kentucky and Indiana. New Fire-Weather offices have been established to provide service in the states of New York and Pennsylvania and the existing Fire-Weather service has been augmented in Louisiana, Arizona, New Mexico and California.

The Department of Agriculture has reported progress in its research into plant-weather relationships. For example, a cooperative plant disease research program, using microclimatic data from weather stations, has resulted in a program which provides forecasts for the potential incidence and spread of downy mildew of lima beans. Growers can now control the disease with limited fungicide applications when an epidemic is threatening. Before the establishment of this program, growers had to routinely spray at considerable expense in order to guarantee a crop.

Investigations of the climatic effects in the production of crop plants has resulted in the isolation of the plant part which is effective in inhibiting freezing. Other research has been aimed at identifying the effects of temperature on growth. Results of these studies may ultimately help define the basic differences between warm- and cool-season species or drought-tolerant and drought-susceptible species.

Basic information has been obtained on the per cent transmission of light of different wavelengths in infested and noninfested cotton bolls, apples, peaches, pecans, tomatoes, grapes, cucumbers, and cornstalks. This information will be helpful in studies on the manipulation of light to cause or break dormancy in the pink bollworm, the corn earworm, the oriental fruit moth, and other insects.

Pesticide research has shown that the persistence of herbicides was generally greater in dry areas and least in the wettest, and under certain conditions covering the entire rainfall magnitude spectrum, herbicides moved downward in the soil profile to a depth of about 4 feet within 3 months after application.

Field study of plant growth and evaporation.

AIR POLLUTION

During the past year, ESSA has provided a field research office of the Department of Health, Education and welfare, with daily information on the depth of the atmospheric mixing layer and the mean wind speed in that layer at all upper air stations in the United States. These parameters form the basis for an objective forecast model of atmospheric pollution potential. In July 1966, ESSA began preparation of air pollution potential forecasts by machine methods.

The Public Health Service of the Department of Health, Education and Welfare is providing meteorological support for abatement activities and has carried out a number of successful research and development studies and experiments.

A system of meteorological scheduling of sulphur dioxide output based on measured values of wind speed, direction and turbulence has been developed.

Urban meteorology research is demonstrating the relationship between the geographic location of sources and the ambient air concentrations of contaminants from such sources. Experiments have been carried out to investigate the transport and diffusion of tracer material from continuous point sources. Numerous other tracer studies have been completed. Studies on the vertical diffusion of aerosols over a city have also been made. As a consequence, there is now a better understanding of the role of the atmosphere in transporting material from a source to the ultimate receptor.

Special sensitive anemometers have been developed for measuring light winds. Systems to measure the three dimensional components of the wind and automatically compute the readout means and fluctuation statistics have been devised. Progress is being made in sonic anemometry and in the development of indirect methods for probing atmospheric temperature and wind.

SUMMARY OF FISCAL DATA

The following tables and charts summarize the fiscal information on activities of the Federal Government in providing meteorological services and in conducting research which has as its immediate objective the improvement of these services. Meteorological activities which are integral to Federal programs in weather modification, water resources, and air-sea interaction are not reported since they are covered in plans prepared by committees of the Federal Council for Science and Technology responsible for coordinating these programs.

The fiscal information is presented by agency and by service and shows FY–67 data, planned activities for FY–68 and the net changes. A comparison between last year's plan and the present one shows some differences in funding for FY–67. The meteorological operations and supporting research figures for FY–67 differ because the budgets reported in last year's plan differed from the funds subsequently appropriated to the agencies for FY–67. The actual appropriations for FY–67 are reflected in this plan.

Military funds are combined, where appropriate, with civilian funds to show the total Federal expenditure for each category of service. The Department of Defense, like the civilian agencies, funds Basic, Aviation, Marine, Other Specialized, and Space Operations Meteorological Services. Some military programs shown in previous years in other service categories are being shown for the first time in this plan under the Basic Meteorological Service. This change has been reflected in both the FY–67 and FY–68 figures.

FEDERAL PLAN FOR METEOROLOGICAL OPERATIONS AND SUPPORTING RESEARCH BY AGENCY

	OPERATIONS			SUPPORTING RESEARCH			TOTAL		
	1967	1968	68 Change	1967	1968	68 Change	1967	1968	68 Change
AGRICULTURE				1,217	1,245	+28	1,217	1,245	+28
AIR FORCE	121,453	125,998	+4,545	6,278	5,334	−944	127,731	131,332	+3,601
ARMY	5,954	6,068	+114	9,933	12,815	+2,882	15,887	18,883	+2,996
AEC	1,429	1,477	+48	862	880	+18	2,291	2,357	+66
COMMERCE	102,167	111,307	+9,140	7,148	7,946	+798	109,315	119,253	+9,938
FAA	23,425	23,718	+293	1,017	1,526	+509	24,442	25,244	+802
HEW				1,274	1,450	+176	1,274	1,450	+176
ICSC	1,084	1,037	−47				1,084	1,037	−47
NASA	1,752	1,920	+168	36,259	52,150	+15,891	38,011	54,070	+16,059
NSF	351	320	−31				351	320	−31
NAVY	38,546	39,226	+680	1,515	1,565	+50	40,061	40,791	+730
TREASURY	6,462	6,873	+411				6,462	6,873	+411
TOTAL	302,623	317,944	+15,321	65,503	84,911	+19,408	368,126	402,855	+34,729

FEDERAL PLAN FOR METEOROLOGICAL OPERATIONS AND SUPPORTING RESEARCH BY SERVICE

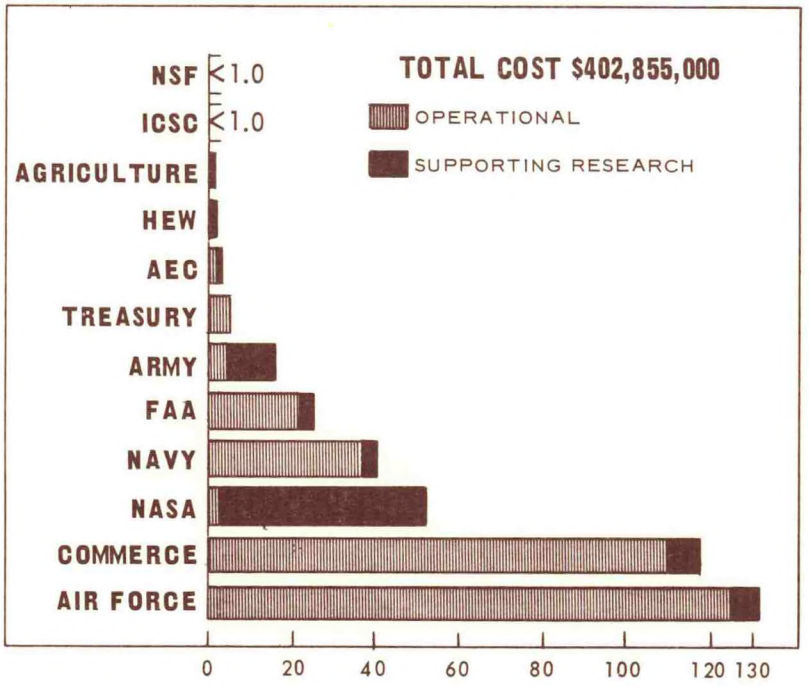
	OPERATIONS			SUPPORTING RESEARCH			TOTAL		
	1967	1968	68 Change	1967	1968	68 Change	1967	1968	68 Change
BASIC	123,502	132,421	+8,919	41,587	58,023	+16,436	165,089	190,444	+25,355
AVIATION	117,021	120,527	+3,506	2,505	2,638	+133	119,526	123,165	+3,639
MARINE	11,856	12,854	+998	168	179	+11	12,024	13,033	+1,009
SPACE OPERATIONS	8,541	8,968	+427	2,018	2,040	+22	10,559	11,008	+449
AGRICULTURAL	3,551	3,633	+82	1,236	1,285	+49	4,787	4,918	+131
GENERAL MILITARY & GROUND FORCES SUPPORT	30,052	31,131	+1,079	15,853	18,416	+2,563	45,905	49,547	+3,642
OTHER SPECIALIZED	8,100	8,410	+310	2,136	2,330	+194	10,236	10,740	+504
TOTAL	302,623	317,944	+15,321	65,503	84,911	+19,408	368,126	402,855	+34,729

FY–68 data on the operational and supporting research programs of each agency are presented in a bar chart to facilitate comparison of agency funding. A second bar chart shows the distribution of operational costs only, between the U. S. and overseas. This chart clearly illustrates the heavy investment in meteorological services that is required to meet military needs outside the continental limits of the United States. Certain funds, such as those for weather reconnaissance and some contracts for missile range support, are included in the United States category because they are contracted for or reported by the parent unit within the United States, although the operations actually may be performed in overseas areas.

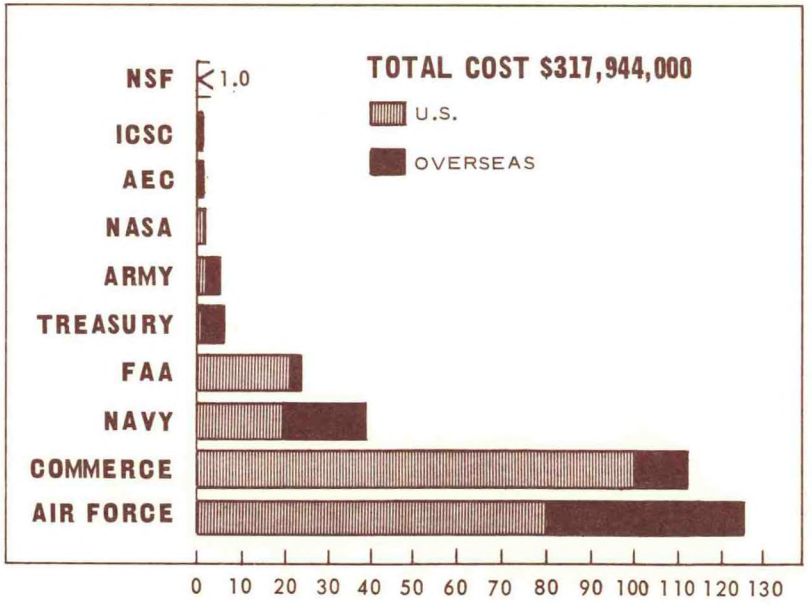
Finally, new to this year's plan are tables showing the extent to which agencies are making use of each other's capabilities through the purchase of meteorological services and/or supporting research by interagency fund transfers.

Operational costs for FY–68 increase by approximately 15 million dollars over FY–67. This increase includes approximately 5 million dollars additional funding by Commerce in support of the National Operational Meteorological Satellite (NOMS) system. Most of the remaining 10 million dollars provides for increased meteorological observations by the Departments of Commerce and Air Force. Increases for surface, upper-air and weather radar programs by the Department of Commerce total 3.2 million dollars. The Air Force program shows an increase of approximately 3.7 million dollars for surface,

DISTRIBUTION OF OPERATIONAL AND SUPPORTING RESEARCH COSTS BY AGENCY, FY-68



DISTRIBUTION OF OPERATIONAL COSTS, U.S. AND OVERSEAS BY AGENCY, FY-68



upper-air, weather reconnaissance and weather radar observations. The largest single Air Force increase is 1.4 million dollars for rocketsonde observations.

Supporting research costs for FY–68 increase about 19 million dollars over FY–67. Of this increase, approximately 16 million represents NASA funding in weather satellite flight projects and other areas of satellite activity, such as advanced studies. An Army increase of about 2.5 million is for the procurement of developmental equipment for the Army Artillery Meteorological Data Sounding System. An increase of about one-half million by the Department of Commerce is for design activity in support of the World Weather Watch.

Funds used throughout this plan represent the total obligational authority required for each year and are presented by fiscal year. Funds are given in thousands of dollars on all tables and in millions of dollars on the bar charts.

INTERAGENCY FUND TRANSFERS FOR METEOROLOGICAL OPERATIONS, FY-67

FUNDS TRANSFERRED FROM	FUNDS TRANSFERRED TO							
	AIR FORCE	ARMY	COMMERCE	FAA	NASA	NAVY	TREASURY	TOTAL
AIR FORCE			1,018	2			40 *	1,060
AEC			612					612
COMMERCE					22,541			22,541
FAA			20					20
ICSC		364	720					1,084
NASA	56		1,111			51		1,218
NSF			351					351
NAVY			2,330					2,330
TOTAL	56	364	6,137	2	22,541	51	40	29,216

* Transferred from Air Force to Commerce and futher transferred to Treasury.

INTERAGENCY FUND TRANSFERS FOR SUPPORTING RESEARCH, FY-67

FUNDS TRANSFERRED FROM	FUNDS TRANSFERRED TO		
	AIR FORCE	COMMERCE	TOTAL
ARMY		475	475
AEC		862	862
FAA	18	325	343
HEW		615	615
NASA		1,197	1,197
NAVY		45	45
TOTAL	18	3,519	3,537

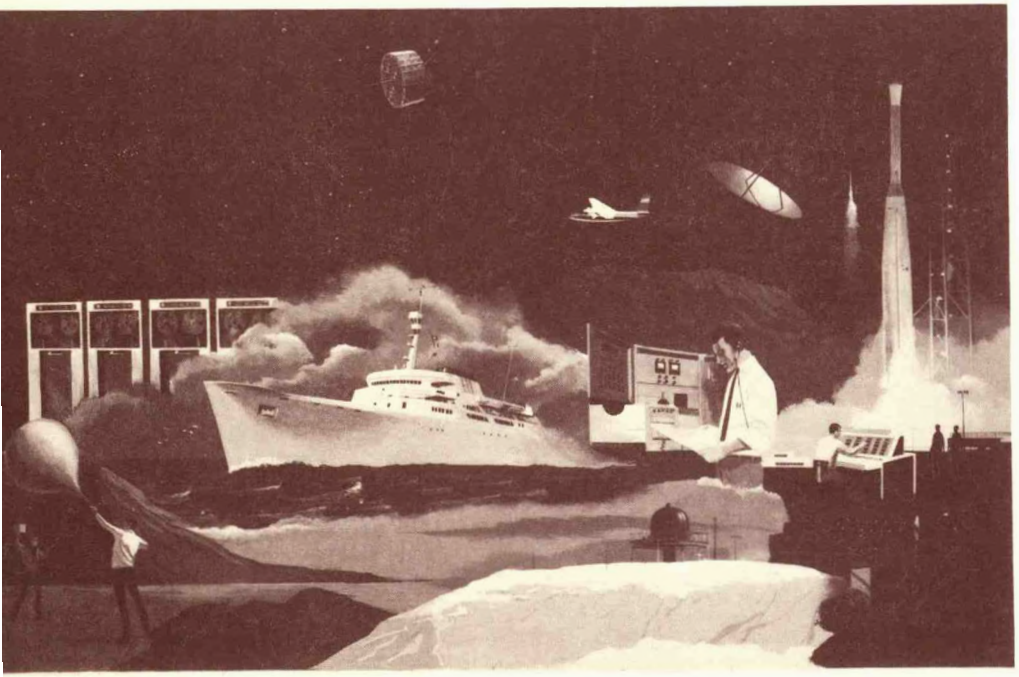
BASIC AND SPECIALIZED METEOROLOGICAL SERVICES

INTRODUCTION

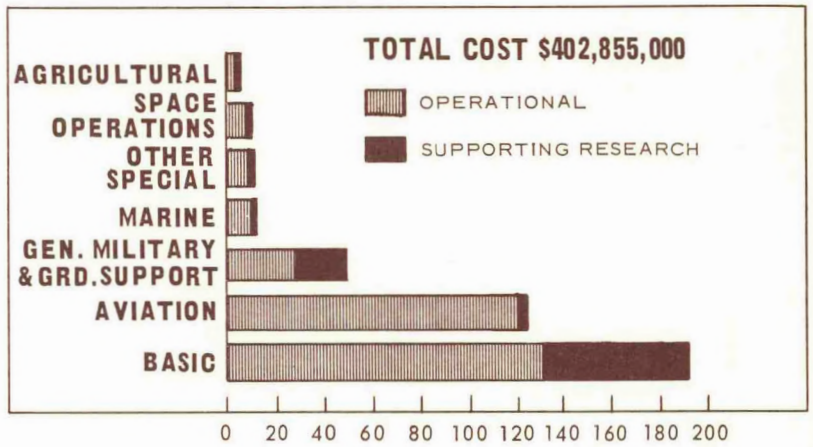
Meteorological services provided by Federal agencies are of two types: basic and specialized.

The Basic Meteorological Service of the United States meets the needs of the general public, fulfills those requirements which are common to two or more user groups, and provides the foundation for the specialized meteorological services.

Specialized meteorological services provide the facilities, products, and distribution mechanisms necessary to serve specific user groups. The specialized meteorological services include those designed for aviation, marine, agriculture, space operations, general military, and other user groups.



DISTRIBUTION OF OPERATIONAL AND SUPPORTING RESEARCH COSTS BY SERVICE, FY-68



BASIC METEOROLOGICAL SERVICE

DESCRIPTION OF SERVICE

The Basic Meteorological Service is the primary source of meteorological information concerning the atmosphere, its motions, and its future state. This service provides the observations and forecasts used by the general public in its daily pursuits and by many segments of the Nation's industry in scheduling production or activities. It issues warnings of impending hazardous and destructive weather occurrences. In addition, the Basic Meteorological Service meets those needs for observations, analyses and forecasts, warnings, and communications which are common to the specialized meteorological services, thereby avoiding duplication of facilities and effort.

The Department of Commerce provides or arranges for the Basic Meteorological Service through its Environmental Science Services Administration (ESSA). The Departments of Defense and Treasury and the Federal Aviation Agency contribute to the Basic Meteorological Service by providing surface observations, upper-air soundings, meteorological rocket soundings, ocean station vessel reports, aircraft in-flight reports, synoptic and tropical storm reconnaissance, high-speed communications from overseas areas, weather

radar reports, climatic data from overseas areas, typhoon warning service for the western Pacific, and primary teletypewriter systems for data collection and exchange in the United States. Although Department of Defense weather facilities are established to meet military requirements, they are utilized to fulfill Basic Meteorological Service requirements, where appropriate, in the interests of overall Federal efficiency and economy.

To provide for its own needs and those of the specialized meteorological services, the Basic Meteorological Service operates four basic observational networks: surface observations; upper-air (balloon-borne) observations; radar observations; and weather satellite observations.

Surface observations are taken from fixed and mobile facilities on land and on ships at sea. Automatic weather observing stations are beginning to be used for essential observations from land areas which are not easily accessible and from buoys at sea.

Upper-air observations of pressure, temperature, humidity, and winds are essential inputs to analyses and forecasts, especially those produced by modern computer systems. The Basic Upper-Air Network is composed of Department of Commerce facilities with military agencies participating at certain bases in the United States and overseas and through support of the meteorological program aboard ocean station vessels and in the Pacific Trust Territory.

BASIC METEOROLOGICAL SERVICE

	OPERATIONS		SUPPORTING RESEARCH		TOTAL	
	1967	1968	1967	1968	1967	1968
AIR FORCE	16,635	17,103	417	360	17,052	17,463
COMMERCE	85,484	93,562	6,890	7,503	92,374	101,065
FAA	6,516	6,595			6,516	6,595
NASA			34,280	50,160	34,280	50,160
NAVY	8,734	8,638			8,734	8,638
TREASURY	6,133	6,523			6,133	6,523
TOTAL	123,502	132,421	41,587	58,023	165,089	190,444

Radar is a vital source of information on such hazardous weather as tornadoes, hurricanes, and flood-producing rainstorms. The Basic Weather Radar Network is composed of Department of Commerce radars with Department of Defense participating at those locations where existing or planned radars can fill the needs of the Basic Meteorological Service and those of the military. Federal Aviation Agency air traffic control radars are also used in the network to provide limited data in western intermountain areas.

The weather satellite program is a major part of the basic observing effort. A network of receivers and remote readouts operated by the Departments of Commerce and Defense ensures reception of local area automatic picture transmissions from the weather satellites at most analysis and forecast centers and certain locations concerned with operations over ocean areas. Worldwide cloud-cover data are provided through ESSA's National Environmental Satellite Center for use by all agencies. A detailed discussion of this important program is presented in a separate section of this plan.

The National Meteorological Center (NMC), operated by ESSA at Suitland, Md., is the principal analysis and forecast center of the Basic Meteorological Service. It provides both manually prepared and computer-produced analyses and forecasts for the Northern Hemisphere to meet the common needs of Federal agencies and all user groups. The volume and diversity of products prepared by the National Meteorological Center has undergone a steady growth in recent years to keep pace with ever-increasing demands for meteorological support.

Forecasts and warnings of severe local storms, including tornadoes, are prepared by ESSA's National Severe Storms Forecast Center at Kansas City, Mo., for the general public, user groups, and some of the specialized services. ESSA's National Hurricane Center at Miami, Fla., prepares forecasts and warnings of hurricanes in the western Atlantic Ocean, Gulf of Mexico, and Caribbean Sea for use by all agencies and the public. Smaller centers in San Francisco and Honolulu provide a similar service for the eastern and central North Pacific Ocean. Typhoon warnings for the Pacific Ocean west of 180° are prepared by the Department of Defense at its Typhoon Warning Center on Guam.

The requirements of the Basic Meteorological Service for climatological data processing are met by ESSA's National Weather Records Center at Asheville, N. C. This center archives the weather records acquired by all Federal agencies and makes processed data and summaries available to support all Federal agencies and user groups. The military services collect and process the majority of weather data from foreign and marine sources for entry into the archives of the National Weather Records Center.

Basic weather observations are collected and exchanged principally by teletypewriter systems operated by the Federal Aviation Agency and the Department of Commerce. Weather charts prepared in basic analysis and forecast centers are distributed by means of Department of Commerce facsimile systems. Weather forecasts and warnings are disseminated to the public through teletypewriter, telephone, and radio systems operated by the Department of Commerce and through mass-dissemination media. In each of these instances, the basic communications systems also support specialized user groups, both civil and military. Specialized weather communications systems,

established to meet Defense requirements, contribute to the Basic Meterological Service.

The Basic Meteorological Service requires substantial improvements in order to meet the growing needs of user groups and the public. Considerable immediate improvement in the ability of the Basic Meteorological Service to describe current conditions and predict their changes for short periods could be achieved by expanding the present observational programs and improving analysis and forecasting facilities. ESSA's Natural Disaster Warning Plan cites the need for improvements in the upper-air observation network, additional weather radar equipment to fill critical gaps in radar coverage, and a satisfactory means of alerting all segments of the public on short notice of impending hazards to life and property. Expanding urban areas have increasing needs for weather information to assist their programs for air pollution control, water resources management, and transportation. United States' participation in the World Meteorological Organization's developing World Weather Watch program for observations, analyses and forecasts, and communications place requirements on the Basic Meteorological Service. Further long-term improvements in the Basic Meteorological Service are needed and expected from proposed supporting research programs.

PLANS FOR SERVICE IMPROVEMENTS

OPERATIONAL PROGRAM

The operational program in behalf of the Basic Meteorological Service reflects an increase of $8,919,000 over FY–67. $5,588,000 of this increase is to be used to provide for necessary observations and to extend the area covered by analyses and forecasts in conformance with World Weather Watch plans. Supporting management functions and communications links must also be supplied.

Funds are being budgeted in the amount of $3,807,000 by the Department of Commerce in FY–68 to augment existing forecasting, observing, and communications systems vested with the responsibility for providing adequate emergency warnings of hazardous weather. This will provide for needed staffing and equipment and for radio and teletypewriter facilities at key locations.

An expenditure of $730,000 is planned for the maintenance of recently purchased equipment to be used in the support of the basic programs and of specialized services. The installation, commissioning, and maintenance of this new equipment impose an additional workload that cannot be accomplished with existing resources. A funded program by the Federal Aviation Agency to improve its basic civil weather communication networks and to add a central automatic message-switching system is proceeding on schedule toward a commissioning date late in 1968.

SUPPORTING RESEARCH PROGRAM

A large part of the supporting research program of the Federal Government is designed to increase knowledge of the dynamics of the general circulation and of smaller-scale weather phenomena of the atmosphere, leading to improvements in the Basic Meteorological Service.

The Department of Commerce plans greater efforts in satellite data analysis during FY–68. The National Aeronautics and Space Administration is planning a significant increase in weather satellite projects in the TIROS and Nimbus programs. The NASA increase is for design, development, integration, and launch support of TIROS M, which will combine into one satellite the capability for imaging both local and global cloud cover, at night as well as during the day. Additionally, system definition, design, and initial procurement of hardware components for Nimbus D are planned.

The National Aeronautics and Space Administration is also engaged in studies for the development of significant meteorological experiments for manned earth-orbiting space applications missions. The studies consist of analyses and preliminary design research leading to detailed definition of the experiment concept, system design, and tests of critical systems and subsystems.

Plans for the World Weather Watch are developing. Significant improvements in long-range forecasting must await the technological advances in global observational methods envisioned in the World Weather Watch program, as well as the results of considerably increased efforts in general circulation research supported by the global observing system. Studies are being conducted of the feasibility of collecting global data by satellite tracking of constant-pressure balloons.

Increased effort is directed at providing major support for the World Weather Watch program and expanding the systems studies to design global data processing, acquisition, and communications subsystems for this program.

Many users require local forecasts for short ranges (less than 12 hours). Greater accuracy in these forecasts is needed, not only in the Basic Meteorological Service but also in all of the specialized meteorological services. A Task Team, operating under the Interdepartmental Committee for Applied Meteorological Research, has examined this major problem. A Federal plan of action, based upon the Task Team report, is expected in June 1967.

Increases are planned for improvements in radar observational techniques by the National Severe Storms Laboratory. Increased capabilities in analysis and forecasting are sought by intensifying the effort to develop severe local storm models, severe local storm forecast techniques, and methods of predicting hurricane development and motion.

The Air Force has a small effort aimed at developing techniques for use of satellite data.

AVIATION METEOROLOGICAL SERVICE

DESCRIPTION OF SERVICE

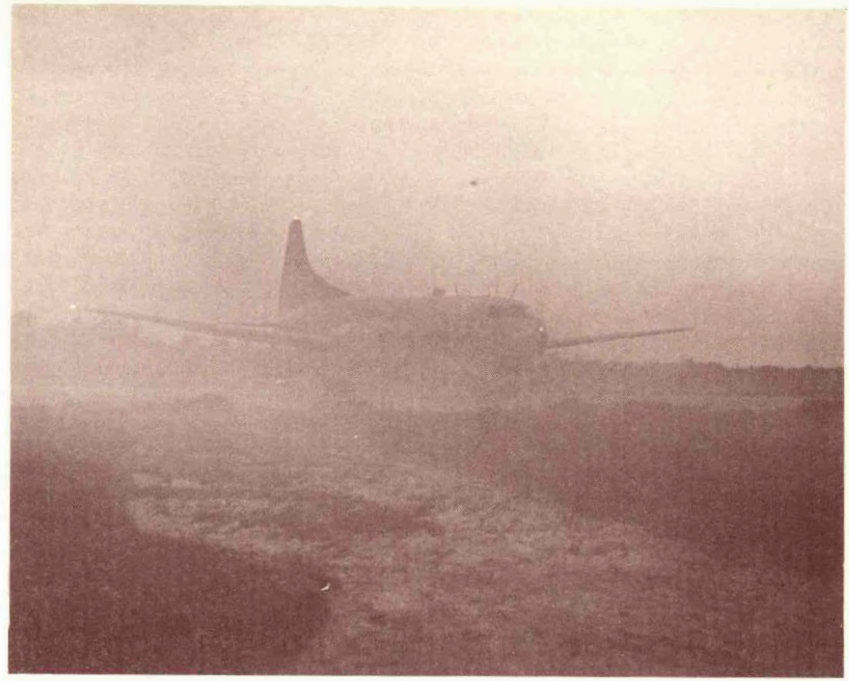
The Aviation Meteorological Service furnishes specialized weather information to pilots, controllers, and aircraft operators in order to promote safety and efficiency in civil and military aviation activities.

The Department of Commerce serves domestic and international civil aviation. The Federal Aviation Agency makes recommendations to the Department of Commerce on civil aviation meteorological services, provides specialized equipment and surface observations at certain airfields, disseminates weather information to users at air navigation facilities, and distributes weather data over civil teletypewriter systems. The Department of Defense serves the needs of military aviation.

Maximum use of the products of the Basic Meteorological Service is made by the Aviation Meteorological Service in providing specialized services required by the aviation community. The principal specialized requirements of aviation are measurements and forecasts of ceilings, visibilities, wind conditions and hazardous weather at air terminals, and wind, cloud, temperature and hazardous conditions aloft over the United States. Specialized observing, analysis and forecasting, communications, and systems for dissemination of data to users are operated to supplement basic services.

Specialized surface observations are made at 447 locations solely in support of aviation. The Department of Commerce provides these observations at 13 locations, the Federal Aviation Agency at 241 locations, the Department of Defense at 190 locations, and the Department of Treasury at 3 locations. At many of these locations the surface observation program is a coordinated effort between the Department of Commerce and the Federal Aviation Agency or one of the Defense agencies to provide required services most economically. Sophisticated instrumentation accurately measures cloud heights, visibility, and wind conditions critical to aircraft landings and takeoffs.

Analyses and forecasts for aviation purposes are prepared by weather centrals and forecast centers. The Department of Commerce operates 22 Flight Advisory Weather Service Centers in the United States in support of domestic aviation; and the Department of Defense operates 5 weather centrals and 11 weather centers in the United States which support military aviation as well as other military operations. These centralized facilities provide area-wide guidance and forecasts for use by local weather offices and briefing facilities at the air terminals. Each Department of Commerce center also prepares detailed local forecasts for the 12 to 36 air terminals in its area of responsibility. Analyses and forecasts for international civil aviation are provided by 6 Department of Commerce centers and 6 Department of Defense weather service offices in accordance with procedures recommended



by the International Civil Aviation Organization. Enroute forecasts of wind, temperature, and weather are provided for the North Pacific, Central American, Caribbean, North Atlantic, and Western European areas.

Weather observations, and other information in support of domestic civil aviation, are collected and exchanged over the Federal Aviation Agency's teletypewriter Service A. Collections and exchanges over the Basic Meteorological Service teletypewriter systems are also used extensively. The Department of Defense uses the Air Force COMET teletypewriter system to meet the needs of military aviation in the United States. International exchanges of aviation meteorological data and information are carried on teletypewriter systems operated by the Federal Aviation Agency. The Basic Meteorological Service's high-speed systems are also used in this respect, and the Air Force Automated Weather Network provides for high-speed collection of data from overseas areas to meet Department of Defense requirements.

Specialized weather charts for aviation purposes are distributed from the analysis and forecast centers to local weather offices and briefing facilities over facsimile systems. The Department of Commerce's basic facsimile systems are supplemented by its High-Altitude Facsimile System, and the Air Force Strategic Facsimile Circuit is used to meet additional specialized requirements of Defense agencies in the United States.

Voice communications systems are used widely in the Aviation Meteorological Service. Federal Aviation Agency air-ground radio systems are used to provide weather information to pilots and transcribed broadcasts of weather observations, forecasts, and advisories are carried on many navigation aids. Automatic telephone-answering systems are also used in larger cities. The Federal Aviation Agency has a telephone network linking airports without a local weather briefing outlet to a nearby Flight Service Station. Pilots use this network to file flight plans and obtain weather briefings for their flights. The Department of Defense operates a network of air-ground radio stations for direct pilot-to-forecaster contact to provide observations, forecasts, and warnings to airborne military pilots on request and to obtain weather reports from military aircraft in flight.

AVIATION METEOROLOGICAL SERVICE

	OPERATIONS		SUPPORTING RESEARCH		TOTAL	
	1967	1968	1967	1968	1967	1968
AIR FORCE	73,374	76,228	623	139	73,997	76,367
COMMERCE	12,920	13,060	200	353	13,120	13,413
FAA	16,909	17,123	1,017	1,526	17,926	18,649
NASA			665	620	665	620
NAVY	13,716	14,013			13,716	14,013
TREASURY	102	103			102	103
TOTAL	117,021	120,527	2,505	2,638	119,526	123,165

The Department of Commerce provides aviation services at 261 weather service offices. The Federal Aviation Agency provides weather briefings to pilots at 333 locations. The Department of Defense operates 188 local weather service offices to meet its own needs and uses civilian facilities and services when feasible and economical.

The Aviation Meteorological Service has a continuing, critical responsibility to advise airborne pilots of hazardous weather conditions related to thunderstorms, wind shear, icing, and turbulence. Techniques for detecting and forecasting these conditions and for relaying this information to control systems and airborne pilots are in need of improvement. Short-term improvements can be realized through additional facilities for observations, analyses and forecasts, and communications. Long-term improvements, however, require substantial supporting research effort.

Modern aircraft and improved landing aids are increasing the capability to operate under adverse weather conditions at more and more air terminals. This is creating demands for additional airfield weather instrumentation and better means of relaying observations to control centers and pilots. Programs to provide this service are needed to keep pace with the rapid technological and economic growth of aviation.

PLANS FOR SERVICE IMPROVEMENT

OPERATIONAL PROGRAM

Significant improvements in the Aviation Meteorological Service are planned for FY–68.

The Department of Commerce plans a $115,000 expenditure to establish a centralized Clear Air Turbulence forecasting unit at the National Meteorological Center and to operate surface weather observation programs at 20 locations which have previously been operated by the FAA. The weather observations at these locations are required not only for aviation but also for public, agricultural and severe weather warning services. This latter action is part of a joint agency plan which will enable substantial reduction in Federal costs.

The Federal Aviation Agency plans to continue its efforts to improve airport meteorological instrumentation at a cost of $324,000.Additionally, the Federal Aviation Agency will improve the primary civil teletypewriter systems by adding automated equipment at a cost of $5,700,000 under prior year funding.

The Air Force plans to begin installing Runway Visual Range computers purchased in prior years; 51 of the 170 computers will be installed in FY–67 at a cost of $102,000.

Weather radar support to aviation is programed for substantial improvements in FY–68 in accordance with the Federal Plan for Weather Radars and

Remote Displays. ESSA programs to improve services from the Basic Weather Radar Network are supplemented by plans of other agencies to improve their aviation-oriented weather radar programs. The Air Force plans an expenditure of $1,404,000 to install 54 new weather radars purchased in prior years, and the Navy plans to purchase and install 8 remote displays in FY–68 at a cost of $80,000, if equipment and procedures tests are successful.

The Navy plans to expand its use of automatic picture transmissions from weather satellites by adding receivers or remote displays at 8 locations. FY–68 expenditures of $80,000 are planned for this purpose.

In addition, many improvements planned for the Basic Meteorological Service will benefit aviation both directly and indirectly. These include improvements in the upper-air network, increased capability at the National Meteorological Center and National Hurricane Center, and improvements in the National Operational Meteorological Satellite System.

SUPPORTING RESEARCH PROGRAM

The Federal Aviation Agency is engaged in a wide variety of supporting research programs designed to improve the Aviation Meteorological Service. In the area of computer preparation of aviation forecasts, the major effort is on terminal weather; an automatic meso-scale network is in operation at Atlantic City and a computer system of predicting ceiling and visibility at numerous terminals is being developed. Increased emphasis is being placed on improvement of observing devices to acquire better data for aviation needs, e.g., visibility, wind, cloud height, runway temperature, altimeter setting, approach and landing turbulence. Additionally, development is continuing on low-cost automatic weather stations for meeting the requirements of low-activity terminals.

In all these programs, the Federal Aviation Agency is collaborating closely with the Department of Commerce. Additionally, the Department of Commerce is developing a system design for improved services to aviation and increasing its effort in the development of techniques for prediction of hazardous aviation weather. The Department of Defense is investigating the climatology of several weather elements, including stratospheric parameters, such as temperature, fine-scale winds, and their small-scale variability.

Clear air turbulence, a formidable problem for both military and civil pilots, is being approached from a variety of standpoints, including supporting research by Department of Defense, Department of Commerce, Federal Aviation Agency, and National Aeronautics and Space Administration. A special committee, under the Federal Coordinator, has recommended a coordinated program to alleviate this problem and suggested areas of responsibility for the various agencies.

The Air Force shows decreased effort for FY–68 in sensor development and in certain forecasting areas related to aviation.

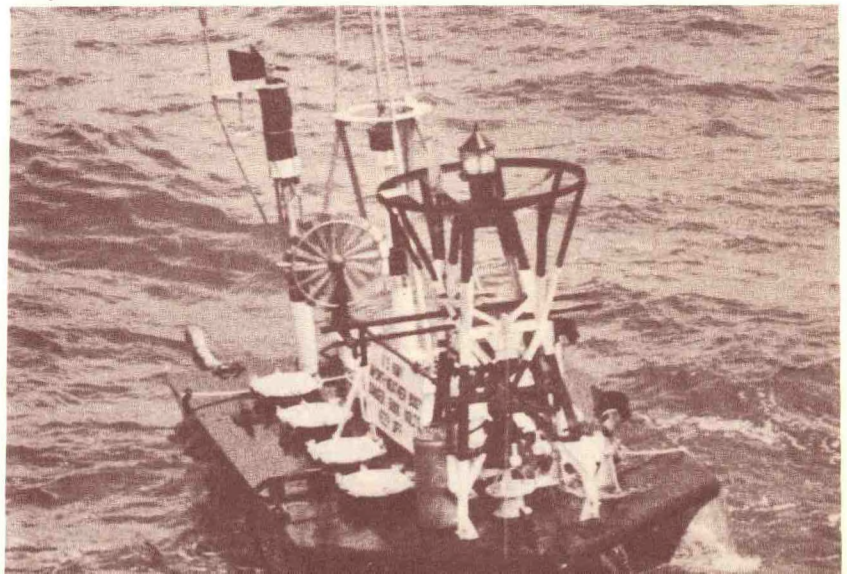
MARINE METEOROLOGICAL SERVICE

DESCRIPTION OF SERVICE

The Marine Meteorological Service provides forecasts, warnings, and other information to promote the efficiency of maritime commerce and naval operations and to ensure the safety of life and property at sea and on coastal and inland waters. Many segments of the economy, including transoceanic and coastal shipping industries, commercial fishing, and industries engaged in offshore drilling and mining, as well as the rapidly growing number of recreational boaters, require detailed weather information. Forecasts of tide, wind, sea state, surf conditions, and storms are vital to these user groups and to the Departments of Defense and Treasury (Coast Guard). Responsibility for providing Marine Meteorological Service is shared by the Departments of Commerce, Defense, and Treasury.

The Department of Commerce is responsible for furnishing weather and warning services to promote the safety of merchant shipping on the high seas and coastal waters, in accordance with international conventions. In fulfilling these responsibilities, the Department of Commerce supplements the Basic Meteorological Service with specialized warnings, forecasts, analyses, and reports for the North Atlantic Ocean, eastern and central North Pacific Ocean, and coastal and inland waterways. Observations from merchant and

Navy weather station—NOMAD



military ships and coastal stations are essential elements of this service.

Weather information for ocean shipping is disseminated by Government and commercial marine radio stations. Bulletins for both merchant and small-boat navigation in coastal and inland waterways are broadcast by marine radio stations operated by the Department of Treasury (Coast Guard) and commercial marine radio companies, as well as by AM and FM radio and TV stations. Continuous radio broadcast facilities providing marine weather information are in operation or in the process of installation by the Department of Commerce at 19 sites. Special marine automatic telephone-answering services are provided at Baltimore, Los Angeles, and Washington, and similar telephone service is in operation at Boston and Providence during the boating season. Warnings of approaching storms are also distributed by means of visual displays at more than 550 stations along the seacoasts, inland waterways, and larger lakes.

The Department of Commerce meteorological support for high-seas merchant shipping and marine interests fulfills only the minimum requirements of the International Safety of Life at Sea and World Meteorological Organization conventions. To provide a Marine Meteorological Service adequate for present-day maritime needs, additional resources are required. In particular, more manpower is required for issuance of adequate forecasts of sea and swell, surf conditions, and ice coverage for northern coastal and Alaskan waters and Great Lakes; resources for facsimile, radio, and telephone transmissions are needed to improve distribution of information to marine users.

The Navy makes use of environmental data collected for the Basic Meteorological Service, supplements these with additional data in certain areas, and prepares detailed analyses and forecasts tailored to the unique requirements of the naval establishment and other military users. The products primarily support air, surface, and subsurface military operations and are given wide dissemination by the Naval Communications System. Significant merchant marine support is also provided by the inclusion of selected meteorological information on the Navy's worldwide broadcasts which, though designed primarily to serve naval vessels, can be received by appropriately equipped merchant ships.

PLANS FOR SERVICE IMPROVEMENT

OPERATIONAL PROGRAM

The Department of Commerce plans an expenditure of $480,000 in FY–68 to establish Marine Forecast Centers on the east and west coasts and to begin radio-facsimile transmissions of weather information for use in marine operations in the North Atlantic and eastern Pacific Oceans. In addition, the National Meteorological Center will produce and disseminate analyses and forecasts of sea-state information which will be used as guidance at field

MARINE METEOROLOGICAL SERVICE

	OPERATIONS		SUPPORTING RESEARCH		TOTAL	
	1967	1968	1967	1968	1967	1968
COMMERCE	175	887	39	50	214	937
NAVY	11,454	11,720	129	129	11,583	11,849
TREASURY	227	247			227	247
TOTAL	11,856	12,854	168	179	12,024	13,033

forecast offices servicing marine interests. Facilities at 17 coastal observation sites will be upgraded, telemetering equipment will be added to 7 coastal tide stations, 15 new coastal observation stations will be implemented, 15 automatic telephones will be installed at coastal points, and 5 VHF continuous broadcast facilities will be installed in the Great Lakes and west coast areas.

The Navy will continue programs which are currently underway for the installation of APT receivers on selected naval ships. Expenditures of $620,000 are planned in FY–68 for these purposes.

SUPPORTING RESEARCH PROGRAM

Supporting research projects to improve the Marine Meteorological Service are conducted by the Departments of Commerce and Defense. The major Defense projects include methods to obtain visibility measurements from ships and aircraft, additional effort on a deep-water instrumented buoy, and the application of lasers to cloud-height measurement from ships.

The Department of Commerce is conducting a small program during FY–67 designed to develop improved techniques for predicting sea and swell, extra-tropical storm surges, and wind-induced tide on Lake Erie. The work on oceanic surface waves is being conducted in close collaboration with the Fleet Numerical Weather Facility in Monterey. It is planned to expand all of these efforts during FY–68 and to inaugurate research on predicting hurricane storm surges, coastal surf and breakers, sea surface temperatures, winds and waves in coastal areas, mixing layer depth, and Great Lakes ice.

Much of the research directed toward improving the Basic Meteorological Service, such as the World Weather Watch efforts, will have a direct application to the Marine Meteorological Service as well.

SPACE OPERATIONS METEOROLOGICAL SERVICE

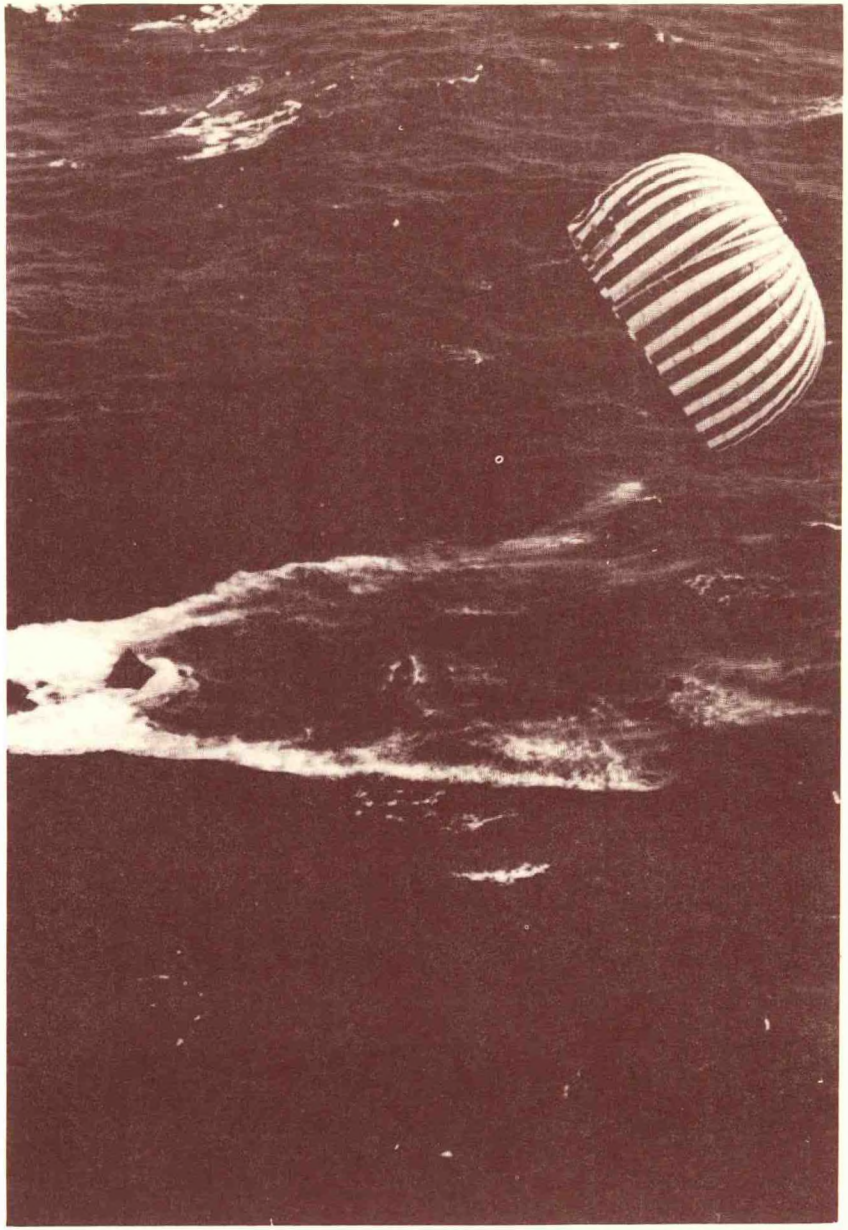
DESCRIPTION OF SERVICE

The Space Operations Meteorological Service provides the specialized weather information required for planning and conducting the Nation's civilian and military space and missile programs. These complex and expensive programs demand highly specialized and sophisticated meteorological support to assure the safety of the personnel involved and the success of the operation. Collection and use of space environmental data are not treated as a part of this service.

Products of the Basic Meteorological Service are used extensively by the Space Operations Meteorological Service. These products are supplemented by the highly specialized programs and products necessary to support the Nation's space and missile activities. Rocket launch sites, missile test ranges, and recovery sites are instrumented to furnish observations of vital weather conditions. Manned and automatic weather stations provide information on conditions near the earth's surface. Radiosonde and rocketsonde observations gather weather information from the earth's surface to altitudes of several hundred thousand feet to determine the conditions missiles and spacecraft will encounter as they are launched or reenter the atmosphere. Weather radar, weather satellite, and Department of Defense weather reconnaissance data are used to provide warnings of approaching storms which could jeopardize rocket launch and recovery operations. Weather forecasts for space operations must cover the period from several days prior to launch of large rockets until recovery of astronauts or impact of test vehicles. The success or failure of a mission depends to a large degree upon how well these tasks are performed.

In its space programs, the National Aeronautics and Space Administration relies primarily on the Department of Commerce for Space Operations Meteorological Service. This service is augmented by the Department of Defense, which takes weather observations on the National Ranges, at Department of Defense installations, and on ships and aircraft throughout the world. In addition, NASA has a limited number of contracts with private industry and with other Federal agencies for weather support to specific NASA programs under its management.

The primary objective of meteorological support for space operations is to supply the necessary data for successful conduct of manned and unmanned space programs. To support the civilian programs, a group of highly trained meteorologists works with the Office of Manned Space Flight, the Manned Spacecraft Center, and the Kennedy Space Center. The spectrum of the effort ranges from participation in design studies of initial launch vehicle and payloads through the actual participation in flight missions.



Gemini 12 splashdown.

SPACE OPERATIONS METEOROLOGICAL SERVICE

	OPERATIONS		SUPPORTING RESEARCH		TOTAL	
	1967	1968	1967	1968	1967	1968
AIR FORCE	5,241	5,446	704	670	5,945	6,116
NASA	1,752	1,920	1,314	1,370	3,066	3,290
NAVY	1,548	1,602			1,548	1,602
TOTAL	8,541	8,968	2,018	2,040	10,559	11,008

The successful conduct of these missions depends to a large extent upon accurate, timely, and comprehensive weather reporting and forecasting. A vast majority of these programs cannot be launched without adequate visibility, optimum wind conditions (both surface and upper-air), and cloud conditions which permit photographic and visual tracking. Again, recovery operations are dependent almost wholly on proper sea state and weather conditions in the recovery zones, since the majority of recoveries are conducted at sea.

The Department of Defense provides the Space Operations Meteorological Services for its Eastern and Western Test Ranges and the Pacific Missile Range. Meteorological support to the White Sands Missile Range is provided from Department of Defense supporting research funds and is not shown in the adjoining table. Networks of surface, radiosonde, rocketsonde, and weather radar stations are located on islands and on ships stationed along the ranges. Planning studies and operational weather forecasting are performed by specialized staffs at range weather stations. The observations are provided by Department of Defense personnel and by contracts with private industry or non-defense agencies, primarily the Department of Commerce.

The rapid sensing and reporting weather observation system needed for space operations support currently exist only to a limited degree. In particular, meteorological data gathered by radiosondes and rocketsondes are required by range operations as soon as possible after launch of the radiosonde or rocketsonde. Because of the slow rise of balloons or long decent time for parachute-borne sensors from rockets and consequent lengthy computations, research effort is required to reduce the response time of the system. Furthermore, the accuracy of weather data must be improved and observations made to higher altitudes to meet the needs of range operations.

The nature of manned space flight requires constant surveillance of worldwide weather conditions throughout a mission period. The facilities of the Departments of Commerce and Defense have been utilized to meet this requirement. However, sufficient data are not obtainable from the Southern Hemisphere and reliance upon meteorological satellites has been instrumental in meeting this need. This fact, and the need for rapid data acquisition on a worldwide basis, indicates that more extensive use of such satellites should be made in the future. This requirement should be constantly re-examined as meteorological satellite systems are proposed to insure that adequate weather data required for support of future manned space flights are obtainable.

PLANS FOR SERVICE IMPROVEMENT

OPERATIONAL PROGRAM

The principal changes in Space Operations Meteorological Service are for improved observations at the National Ranges. Air Force plans to install three new weather radar sets purchased with prior year funds. Improved meteorological services for manned spaceflight launches are planned at Kennedy Space Center. A real-time weather radar display system will be installed using a remoting system from the Air Force weather radar at Patrick AFB, Fla., to improve weather watch for manned spaceflight equipment and personnel.

SUPPORTING RESEARCH PROGRAM

The National Aeronautics and Space Administration is developing improved methods to measure and establish the climatology of vertical wind profiles. These projects involve studies of wind from the surface to high altitudes by use of towers, rockets, and associated equipment such as sensors, balloons, and advanced radars. Results are applicable to problems of resolving wind effects on space vehicles on the launching pad, during ascent, and on reentry.

The Department of Defense is studying instrumentation for rockets, meteor-trail wind equipment, and measurement techniques; the climatology of vertical and horizontal winds, density, and other parameters; and sensor-calibration equipment and rocket systems. The results of these projects will apply to reentry problems of space vehicles.

AGRICULTURAL METEOROLOGICAL SERVICE

DESCRIPTION OF SERVICE

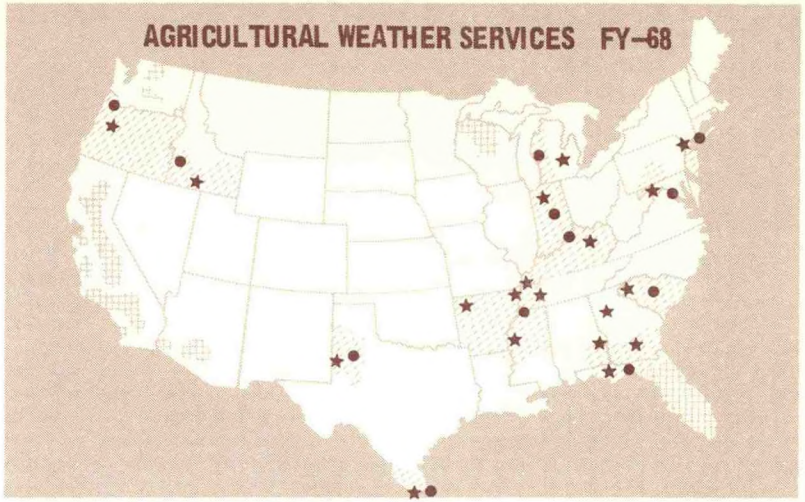
The Agricultural Meteorological Service provides specialized observations, forecasts, warnings, and reports to the agricultural community and forestry and range management interests. The Department of Commerce is responsible for planning and conducting this service. The Departments of Agriculture and Interior assist in planning and participate in cooperative programs for observations, communications, and distribution of information to users.

Two programs are operated by the Department of Commerce to provide this service to agriculture and forestry-range management user groups. A recently completed Federal Plan for a National Agricultural Weather Service develops weather services specifically designed to contribute to user decisions which will minimize losses due to adverse weather conditions and improve yield and quality of agricultural products. The adjoining map shows the 12 areas now provided specialized agricultural weather service.

A Fire Weather program is also operated by the Department of Commerce to provide specialized service to support decisions on presuppression, suppression, fire use, and other forest and range management activities of Federal, state and private interests. The Fire Weather program began in 1961 as a nine-phase plan to expand these services nationwide. Four phases have been implemented according to the Department of Commerce Plan for a Nationwide Fire Weather Service. The adjoining map shows those areas now provided Fire Weather Service.

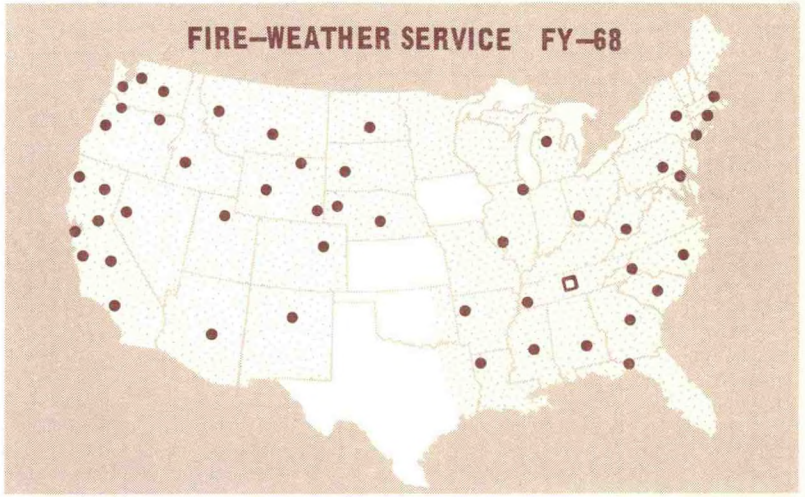
The Agricultural Meteorological Service draws heavily upon the Basic Meteorological Service for information derived from the surface, radar, and upper-air observing networks, analyses and forecasts prepared by the National Meteorological Center and other centers, and communications systems operated by both the Department of Commerce and the Federal Aviation Agency. Specialized observing, analysis and forecasting, communications, and dissemination to user functions are conducted to supplement the Basic products.

Networks of specialized observation locations are maintained in areas served by the agricultural and fire weather programs. These networks gather the detailed data representative of the agricultural and forest areas remote from the normal observing sites in or near cities. In most cases, the observations are made on a cooperative basis between the Department of Commerce and other Federal agencies, states, or private interests. Nearly 13,000 private citizens serving without pay provide daily measurements of air temperatures, soil temperatures, rainfall, and evaporation in crop areas. Observing programs are also carried on in cooperation with Federal and state agencies at agriculture experiment stations, colleges, and universities to obtain detailed micrometeorological data for use in studies of agriculture-meteorology



relationships. Approximately 1100 fire-weather observing stations operate on a seasonal basis in forested areas to furnish daily reports of wind, temperature, humidity, dewpoint, rainfall, fuel moisture, clouds and weather, and thunderstorms. In most cases, these observations are made at fire-control agency stations with costs borne by the agency. The Department of Commerce also uses truck-mounted and "suitcase" equipment which can be quickly moved to the scene of a fire to provide on-the-spot observations in support of fire-fighting operations.

The effectiveness of the Agricultural Meteorological Service depends in



AGRICULTURAL METEOROLOGICAL SERVICE

	OPERATIONS		SUPPORTING RESEARCH		TOTAL	
	1967	1968	1967	1968	1967	1968
AGRICULTURE			1,217	1,245	1,217	1,245
COMMERCE	3,551	3,633	19	40	3,570	3,673
TOTAL	3,551	3,633	1,236	1,285	4,787	4,918

large measure upon adequate two-way communications to insure timely receipt of observations at the analysis and forecasting offices and transmission of forecasts, warnings, and advisories to users. Teletypewriter networks, operated by the Department of Commerce, disseminate these products to users and mass media in each of the 12 areas now provided agricultural weather service. Communications systems, including two-way radios, of the Federal and state fire control agencies are also used extensively to collect observations and distribute forecasts and warnings, supplementing fire-weather teletypewriter circuits of the Department of Commerce.

Forecasts for agricultural users—ranging from short periods for precipitation affecting planting, harvesting, and crop dusting and spraying, to a 30-day outlook for general agricultural planning—are prepared at an Agricultural Weather Forecast Office located in each of the 12 service areas. Interpretive and consulting services are provided by 19 Agricultural Weather Service Offices located at Federal or state experimental stations.

Forecasts for fire-weather users—ranging from 36- to 48-hour general forecasts of weather patterns and meteorological elements such as winds, temperature, rainfall, humidity, thunderstorms, and fuel moisture for large areas, to short-period forecasts for a specific going fire, or warnings of unusually high fire danger in a forest—are prepared at forecast centers and offices by specially trained personnel. Broad-scale guidance is provided by three ESSA Area Forecast Centers which also have been designated as Fire Weather Guidance Centers. Forty Primary Fire Weather Offices, staffed with specially trained personnel, provide detailed forecasts to local users within their assigned districts, and 10 Supplementary Fire Weather Offices provide similar support in addition to their normal public weather service functions. Twenty truck-mounted mobile units with two-way radio and radio facsimile deploy to major fires to provide immediate support to the fire-fighting operations.

PLANS FOR SERVICE IMPROVEMENT

OPERATIONAL PROGRAM

The Federal Plan for a National Agricultural Weather Service prepared under the Federal Coordinator for Meteorological Services and Supporting Research by the Departments of Commerce and Agriculture sets forth a 10-phase program for extending the existing specialized services to agricultural users throughout the Nation. Concentrations of weather-sensitive crops and livestock, importance of agricultural production to the economy, and availability of other weather services were the principal considerations in determining priority for expanding agricultural weather services. The total annual cost after full implementation is estimated at approximately $7.9 million. This expenditure is expected to produce economic benefits of 35 to 50 times the annual investment.

The Department of Commerce also plans FY–68 expenditures of $75,000 to improve the Fire Weather Service by establishing services in Tennessee and expanding existing services in the Northern and Central Rocky Mountain areas. Long-term plans envision completing the Fire Weather Service expansion program in FY–70.

The Agricultural Meteorological Service will also derive substantial benefits from the planned improvements in the Basic Meteorological Service. Improvements in basic observation networks, such as weather radar and upper-air, and expansion of the statewide public dissemination teletypewriter circuits will contribute to better and more timely specialized agricultural and fire-weather products.

SUPPORTING RESEARCH PROGRAM

The major effort in this area is being funded by the Department of Agriculture. It is conducting research in agricultural climatology including the effects of climate on plant growth, plant disease, and insect behavior, and in statistical studies of drought probability as related to irrigation feasibility, days with runs of certain types weather, and plant phenology. In the area of fire-weather, the Department of Agriculture is supporting research on the pattern of thunderstorm and lighting strikes in Alaska, the influence of weather and climate on fuel and forest-fire behavior in the southeast United States, and the relation of weather patterns to forest-fire behavior in the Pacific Southwest.

The only other agency with effort in this area is the Department of Commerce, which has a small program to develop techniques for improved prediction of weather elements of importance to agriculture and fire weather. This work is concentrated on temperature, precipitation, humidity, crop-growth indices, and soil moisture in agricultural areas, as well as on surface winds, dewpoint, temperature, and fuel moisture in national forests.

GENERAL MILITARY AND GROUND FORCES SUPPORT METEOROLOGICAL SERVICE

DESCRIPTION OF SERVICE

To fulfill their mission of preserving the Nation's peace and security, the military forces of the Department of Defense require worldwide meteorological support. The General Military and Ground Forces Support Meteorological Service provides that support which is not available from the Basic Meteorological Service or from other specialized meteorological services.

This specialized service generally applies to those military meteorological service functions which are common to the needs of two or more classes of military users. It does not include services which support specific military users such as aviation, marine, and space operations. Support for these users is included in the sections on the relevant specialized meteorological services.

The requirements of military user groups are varied. Meteorological information often must be tailored to the particular weapon system being developed or employed; specialized forecasts and analyses are needed by command and control systems; specialized information, such as ballistic data, is required by field armies; and general meteorological support is required in the training and deployment of military forces and in contingency operations.

The Army performs meteorological services in support of its chemical, biological, radiological, surveillance, artillery, and missile activities. With these exceptions, the Air Force and Navy meet the General Military and Ground Forces Support Meteorological Service requirements of the Department of Defense. To provide this service, these Departments maintain analysis and forecasting facilities in the United States and overseas. The Air Force operates a Global Weather Central at Offutt AFB, Nebraska, and forecasting centers in Europe, the Pacific, and the Far East. The Navy operates a Fleet Numerical Weather Facility at Monterey, California, and Fleet Weather Centrals and Facilities in Europe, the Pacific, and the Far East. Specialized centers—such as the Air Force portion of the climatological activity at Asheville, N.C.—also fulfill unique military meteorological requirements. Similarly, Department of Defense observing facilities are operated to obtain data in direct support of military operations, and military communications networks are maintained to collect and exchange observations and disseminate forecasts.

PLANS FOR SERVICE IMPROVEMENTS

OPERATIONAL PROGRAM

The General Military and Ground Forces Support Meteorological Service relies in large measure on information available through the basic and specialized meteorological services of the United States and other nations and will benefit from any improvements planned in these services. Improvements planned by the United States in the Basic Upper-Air and Weather Radar Networks, the weather satellite system, and the civil weather communications systems will be of particular value.

Department of Defense agencies also are expending considerable effort to improve systems for the collection and dissemination of meteorological information. The Air Force has established a high-speed data-collection system linking Europe and the Middle and Far East with the United States and is using this capability to distribute products to its overseas units. The Navy's Monterey facility and ESSA's National Meteorological Center are connected to this collection system. The Navy has a high-speed digital dissemination system linking its primary center at Monterey with the Fleet Weather Centrals and Facilities in the United States and overseas. This system is programed for further expansion in subsequent years to link all Navy centers to the primary center.

SUPPORTING RESEARCH PROGRAM

The Department of Defense is presently developing several items of tactical equipment to enhance meteorological support to the forces in the field. Meteorological equipment under development include: a meteorological data sounding system that will automate upper-air sounding operations; a lightweight portable weather observing pack that can be used to support tactical operations in the forward areas of the battlefield; a mobile weather radar to assist in the forecasting of soil trafficability and river and flood stages by observing the location of rain clouds and by measuring the intensity of precipitation; a portable automatic weather observing station that will be self-powered and capable of measuring and transmitting weather information from inaccessible areas; and a fast-rising balloon system to include a mobile hydrogen generator which can produce hydrogen gas for sounding balloons efficiently and economically, sounding balloons with faster rates of rise, and a lightweight, rugged, portable balloon inflation-launcher device. Artillery and forecasting meteorological units will be equipped with the balloon inflation-launcher device by the middle of FY–68.

GENERAL MILITARY AND GROUND FORCES SUPPORT METEOROLOGICAL SERVICE

	OPERATIONS		SUPPORTING RESEARCH		TOTAL	
	1967	1968	1967	1968	1967	1968
AIR FORCE	22,011	22,868	4,534	4,165	26,545	27,033
ARMY	5,954	6,068	9,933	12,815	15,887	18,883
NAVY	2,087	2,195	1,386	1,436	3,473	3,631
TOTAL	30,052	31,131	15,853	18,416	45,905	49,547

The Department of Defense supporting research projects also include extensive rocket and gun-launched atmospheric sounding system developments, analysis of data gathered thereby, and weather variability studies based on these data. Data from all sources go into a substantial program in climatology applicable to systems or equipment design, operational planning, and direct support for field operations.

Techniques are being developed to use atmospheric structure and motions to aid in locating artillery fire and obtaining artillery accuracy.

Several projects are devoted to the use of radar for severe storm short-range forecasts, the development of numerical prediction techniques, and the application of weather satellite data for military needs.

Pilot reports are a major source of valid weather data in Vietnam.

OTHER SPECIALIZED METEOROLOGICAL SERVICES

DESCRIPTION OF SERVICES

There are several Federal agencies and user groups whose needs for specialized service, though vital to their missions, are small in relation to the specialized services discussed earlier. In general, these agencies require weather services to support research and development activities. Such programs include:

- ***The Department of Defense programs for meteorological support to its research, development, testing, and evaluation activities (other than space and missiles), such as aircraft design and testing, support to geophysical laboratories, and Antarctic research operations.***
- ***Atomic Energy Commission programs for meteorological support to its laboratories and test sites.***
- ***Interoceanic Canal Studies Commission program for meteorological support of its activities.***
- ***National Science Foundation support to an International Antarctic Analysis Center and observations in the Antarctic and aboard a research ship in the Antarctic Ocean.***
- ***Departments of Commerce and Health, Education and Welfare programs concerned with air pollution.***

PLANS FOR SERVICE IMPROVEMENT

OPERATIONAL PROGRAM

These programs generally continue from year to year with only relatively small changes in funding since they support stable, on-going activities. There are two significant exceptions. The first is the Interoceanic Canal Studies Commission project for making meteorological studies to aid in determining the feasibility of excavating an interocean sea-level canal across the Central American Isthmus. It began in FY–66 with funding for initial installation of facilities for surface, upper-air, and radar observations. Funding in FY–67 was reduced considerably below that for FY–66, since only operating costs were involved. FY–68 expenditures are to continue at about the same level as FY–67. Programs concerned with air pollution are the second exception. The

OTHER SPECIALIZED METEOROLOGICAL SERVICES

	OPERATIONS		SUPPORTING RESEARCH		TOTAL	
	1967	1968	1967	1968	1967	1968
AIR FORCE	4,192	4,353			4,192	4,353
AEC	1,429	1,477	862	880	2,291	2,357
COMMERCE	37	165			37	165
HEW			1,274	1,450	1,274	1,450
ICSC	1,084	1,037			1,084	1,037
NSF	351	320			351	320
NAVY	1,007	1,058			1,007	1,058
TOTAL	8,100	8,410	2,136	2,330	10,236	10,740

increasing concern over air pollution, particularly in urban areas, is reflected in additional steps by the Department of Commerce to provide meteorological services directed toward this problem. These steps include a program to forcast air pollution potential at selected locations.

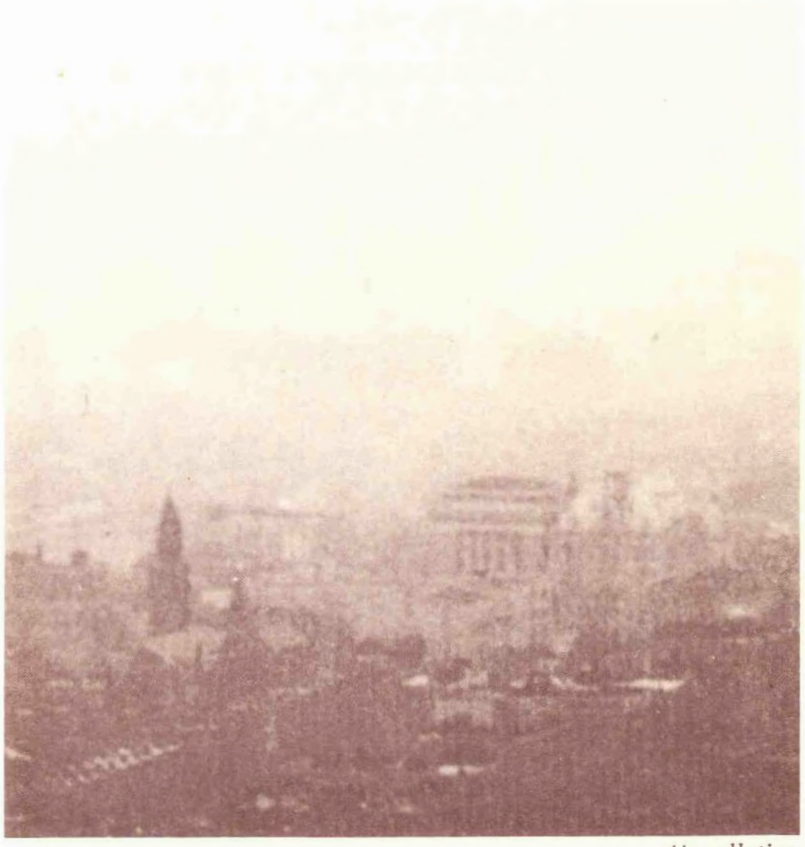
SUPPORTING RESEARCH PROGRAM

The Department of Health, Education and Welfare is conducting supporting research to solve problems connected with air pollution. These funds are transferred in part to the Department of Commerce, and also are provided to non-governmental organizations.

Primarily, these projects are concerned with urban air pollution, its measurement, and the development of forecasting techniques. Thus, considerable emphasis is placed on the analysis of the small-scale wind structure and low-level turbulence, in order to establish relationships for atmospheric diffusion.

The Department of Health, Education and Welfare is increasing its efforts in FY–68 toward solution of the major and growing problem of air pollution confronting the Nation. An ultraviolet radiation facility will start monitoring the ultraviolet radiation available for initiating photochemical reactions in the atmosphere. Increases are planned for research on abatement, expanding efforts on the climatology of air pollution potential, determination of factors affecting ground-level concentrations of pollutants from large power plants and from urban complexes, and urban-diffusion modeling.

The Atomic Energy Commission is transferring funds to the Department of Commerce for the development of techniques for predicting transport and diffusion of airborne radioactivity resulting from nuclear activities.



Air pollution.

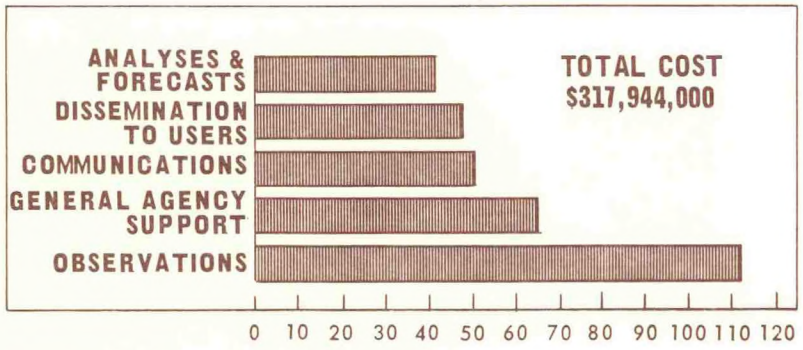
WEATHER OPERATIONS— A FUNCTIONAL DESCRIPTION

INTRODUCTION

Five distinct functions are common to all meteorological services, both basic and specialized. These are observations, analyses and forecasts, communications, dissemination to users, and general agency support. In this section of the plan, the total Federal program for each of these functions is presented.

Distribution of FY–68 funds among these functions is shown in the accompanying bar graph. Distribution by agency of the funds and manpower required to perform each function is depicted in the tables "Agency Operational Costs by Function" and "Agency Personnel Engaged in Weather Operations by Function".

DISTRIBUTION OF OPERATIONAL COSTS BY FUNCTION, FY-68



AGENCY OPERATIONAL COSTS BY FUNCTION

	OBSERVATIONS		ANALYSES & FORECASTS		COMMUNICATIONS		DISSEMINATION TO USERS		GENERAL AGENCY SUPPORT		TOTAL	
	1967	1968	1967	1968	1967	1968	1967	1968	1967	1968	1967	1968
AIR FORCE	29,280	33,036	9,483	11,216	25,886	21,749	27,504	27,910	29,300	32,087	121,453	125,998
ARMY	4,785	4,785							1,169	1,283	5,954	6,068
AEC	755	760			55	60	234	245	385	412	1,429	1,477
COMMERCE	45,097	49,740	22,785	24,269	5,686	6,715	12,524	13,580	16,075	17,003	102,167	111,307
FAA	1,927	1,295			16,137	15,958	1,144	1,328	4,217	5,137	23,425	23,718
ICSC	567	651			8	11	48	62	461	313	1,084	1,037
NASA	686	766	579	605	205	226	26	31	256	292	1,752	1,920
NSF	321	320	30	0							351	320
NAVY	14,512	14,763	5,116	5,547	5,220	5,298	4,539	4,683	9,159	8,935	38,546	39,226
TREASURY	6,161	6,549	85	96	172	180	26	30	18	18	6,462	6,873
TOTAL	104,091	112,665	38,078	41,733	53,369	50,197	46,045	47,869	61,046	65,480	302,623	317,944

AGENCY PERSONNEL ENGAGED IN WEATHER OPERATIONS BY FUNCTION

	OBSERVATIONS		ANALYSES & FORECASTS		COMMUNICATIONS		DISSEMINATION TO USERS		GENERAL AGENCY SUPPORT		TOTAL	
	1967	1968	1967	1968	1967	1968	1967	1968	1967	1968	1967	1968
AIR FORCE	2,171	2,153	1,173	1,306	1,358	1,938	3,944	4,103	4,390	4,681	13,036	14,181
ARMY	780	780							92	92	872	872
COMMERCE	1,699	1,796	1,273	1,318	177	216	1,174	1,205	1,162	1,181	5,485	5,716
	(648)	(648)	(191)	(191)	(2)	(2)			(147)	(147)	(988)	(988)
FAA	114*	106*			1,536*	1,485*	130*	151*	304*	373*	2,084*	2,115*
NASA	20*	17*	30	32	1	0	1	2	6	8	58*	59*
NAVY	841*	909*	599*	605*	368*	367*	579*	585*	534*	434*	2,921*	2,900*
TREASURY	679**	679**	16	16	8*	8*	5*	5*	2*	2*	710**	710**
					(6)	(6)					(6)	(6)
TOTAL	6,952*	7,088*	3,282*	3,468*	3,456*	4,022*	5,833*	6,051*	6,637*	6,918*	26,160*	27,547*

( ) Indicates Departments of Commerce and Treasury personnel funded by other agencies. These personnel are totaled separately for each agency but are included in column totals. Personnel for Atomic Energy Commission, Interoceanic Canal Studies Commission, and National Science Foundation meteorological services programs and the majority of personnel for NASA meteorological service programs are included in Commerce ( ) figures.

* Indicates or includes man-years of effort rather than positions since many functions are performed as part time tasks by personnel assigned to other primary jobs.

** Includes 642 personnel representing 25% of personnel required to man the ships used in the Ocean Station Vessel Program.

OBSERVATIONS

Federal agencies plan expenditures of $112.665.000 in FY–68 for weather observations. This represents an increase of $8.574.000 over the FY–67 agency program for this function.

Observing the state of the atmosphere is the first step in providing weather service and requires 35 percent of the funds for weather service operations. Today, the complex needs of the general public, national defense, and such segments of the economy as aviation and agriculture require knowledge of weather conditions all over the globe, from the earth's surface to several hundred thousand feet. New information of many types must be gathered at frequent intervals to indicate changes taking place in the atmosphere.

SURFACE OBSERVATIONS

Surface weather observations at 1321 locations will require a total of $26.056.000 in Federal funds for FY–68, an increase of $492.000 over FY–67.

Surface observations are made by instruments located on or near the earth's surface to measure various weather elements, including air temperature, humidity, wind speed and direction, dewpoint, barometric pressure, cloud heights, and precipitation. The elements observed and the equipment used are to a large measure determined by the purpose of the observations. For example, surface observations for Basic Meteorological Service uses are generally made at 3- or 6-hourly intervals and concentrate on the elements necessary for descriptions of the atmosphere in analyses and forecasts; a specialized service such as aviation concentrates on the elements of concern to aircraft operations and requires a continuing watch for changing conditions in addition to scheduled observations. The high-performance characteristics and demanding missions of military aviation, particularly limited-endurance fighter aircraft on air defense missions, require precise, up-to-date information concerning airfield weather conditions. To insure safety and efficiency of air operations, Air Force control agencies require a continuous weather watch 24 hours per day, using modern weather-observing instrumentation supplemented with a visual assessment of the weather from a vantage point which has an unrestricted view of the airfield complex.

The Federal Coordinator for Meteorological Services and Supporting Research is sponsoring a study to determine the future role of automatic weather stations for obtaining surface weather observations from remote locations and to develop a coordinated interagency program for their development, procurement, and use. The following summaries of land and marine surface observations illustrate the relatively dense coverage over the United States and the sparse coverage over the vast ocean areas.

SURFACE OBSERVATIONS
(Land Stations)

AGENCY	LOCATIONS FY-67	LOCATIONS FY-68
Department of Commerce	654	674
Federal Aviation Agency	285	282
Department of Defense	336	353
Department of the Treasury	3	3
National Aeronautics and Space Administration	2	2
Atomic Energy Commission	3	3
Interoceanic Canal Studies Commission	4	4

(Cooperative stations operated by Departments of Agriculture, Interior, and Treasury are not included.)

SURFACE OBSERVATIONS
(Marine)

AGENCY	LOCATIONS FY-67	LOCATIONS FY-68
Department of Commerce (Moving Vessels With Meteorological Personnel)	18	18
Department of Commerce (Merchant Ships)	Variable	
Department of Commerce (Automatic Stations and Buoys)	1	2
Department of the Treasury (Coast Guard Icebreakers)	8	8
Department of Defense (Ships With Meteorological Personnel)	73	74
Departments of Defense and Treasury (Ocean Station Vessels)	6	6

A number of changes in surface observation programs are planned for FY–68. The Department of Commerce plans to continue its modest program to expand and modernize coastal reporting networks. The Department of Commerce will assume responsibility for observations at 20 airports to allow the Federal Aviation Agency to withdraw its personnel and thereby reduce Federal costs for observations at these locations. The Federal Aviation Agency plans to complete its multi-year program for equipping a number of airports with modern observing instruments, and to continue its long-term program to equip its control towers with digital displays of weather elements critical to aircraft takeoffs and landings. The Air Force plans to install Runway Visual Range computers, purchased with prior year funds, at 69 bases and to install the remaining 60 computers in FY–69. In addition, 75 Message Composer Consoles will be procured from FY–67 funds for installation in later years. The Navy plans to modify its automatic weather stations undergoing operational testing and to renew the nuclear fuel in those powered by atomic reactors.

UPPER-AIR OBSERVATIONS

Upper-air observations, made by balloon- and rocket-borne sensors, involve a planned Federal expenditure of $34,126,000 in FY–68, an increase of $3,345,000 over FY–67.

To predict changes in the atmosphere, the meteorologist must have information on existing weather conditions above the earth's surface. The most common method of obtaining this information to about 100,000 feet is the radiosonde, a small instrument which is carried aloft by a balloon to measure the vertical distribution of wind, pressure, temperature, and humidity. A Basic Upper-Air Network composed of Department of Commerce radiosonde stations, supplemented by Defense facilities in the United States and overseas, provides upper-air observations for general analysis and forecasting. This network is shown on the accompanying map. In addition, upper-air observations are taken aboard Department of Defense ships and the Department of Treasury's Ocean Station Vessels, in overseas areas for military programs, at test ranges both in and outside the United States for specialized services, and by mobile facilities for severe storm, fire weather, and other programs.

The Federal Coordinator for Meteorological Services and Supporting Research is sponsoring development of a Federal Plan for Upper-Air Observations which will bring together requirements of all agencies and establish a coordinated long-term program to meet these requirements most effectively and economically. Prior actions to consolidate specialized and basic upper-air facilities have continued. An adjustment in the Department of Commerce program allowed the Navy to close its radiosonde station at Corpus Christi, Texas, and through cooperation of the Atomic Energy Commission and the Department of Commerce, the radiosonde facilities at Las Vegas and Yucca Flats, Nevada, have been consolidated into a single facility at Yucca Flats. Substantial net savings accrue to the Federal government through these and similar actions under consideration.

Balloon-borne upper-air observations planned for FY–68 require funds in the amount of $28.851,000, an increase of $1,926,000 over FY–67. This program is summarized as follows:

UPPER-AIR OBSERVATIONS
(Balloon)

AGENCY	LOCATIONS FY-67	LOCATIONS FY-68
Department of Commerce (U.S.)	86	86
Department of Commerce (Overseas)	45	45
Department of Defense (U. S.)	16	21
Department of Defense (Overseas)	22	21
Department of Defense (Ship)	52	55
Department of Defense (Mobile)	67	67
Departments of Defense and Treasury (Ocean Station Vessels)	6	6
National Aeronautics and Space Administration (U. S.)	2	2
Atomic Energy Commission (U.S.)	2	2
Interoceanic Canal Studies Commission (Overseas)	4	4

Several significant improvements and additions to the upper-air observation program of the Federal government are planned for FY–68. To improve the Basic Upper-Air Network in the United States, the Department of Commerce plans to establish a new rawinsonde station at Centralia, Illinois and relocate two existing stations. Overseas, Commerce plans to establish two new Mexican cooperative stations, assume responsibilities in FY–68 for the Navy operation at Trinidad, and assume funding responsibility from the Navy for additional observations at five stations in the Pacific Trust Territory to meet common requirements of the Departments of Commerce and Defense. The Air Force plans an increase in frequency of observations at a numbr of its locations. Navy's overall expenditures will increase slightly. This results from an increase in shipboard programs and a decrease from transfer of responsibility to Commerce for observations from Trinidad and in the Pacific Trust Territory. The Department of Treasury plans to continue its long-term program for modifying military radars on the Ocean Station Vessels so that upper-wind data may be obtained to 100,000 feet.

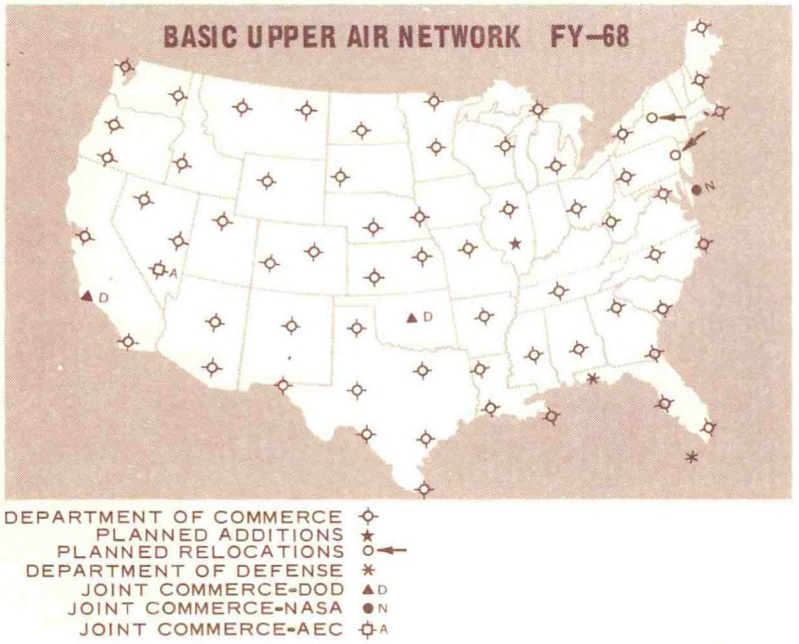
To supplement the upper-air data obtained by balloon-borne sensors, weather observations are made by means of instrumented rockets, called rocketsondes, to determine the environment above 100,000 feet for missile and manned vehicle operations, for climatology, and for basic research. The density of the atmosphere at high altitudes, for example, is a critical factor in the decay rate of orbiting spacecraft and in the reentry of space vehicles.

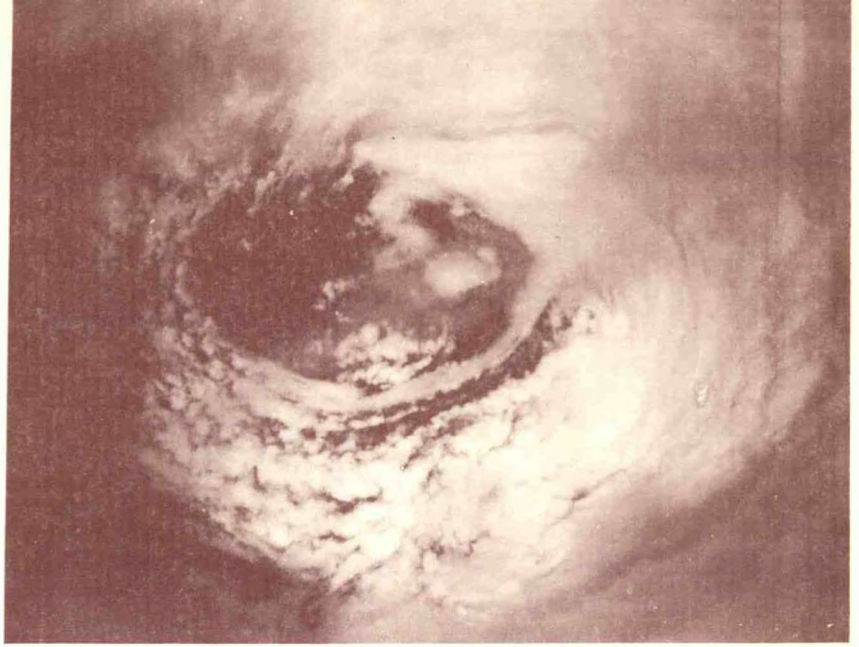
Rocketsonde operations planned for FY–68 require funds in the amount of $5,275,000, an increase of $1,419,000 over FY–67. This program is summarized as follows:

UPPER-AIR OBSERVATIONS
(Rocket)

AGENCY	LOCATIONS FY-67	LOCATIONS FY-68
National Aeronautics and Space Administration (U.S.)	1	1
Department of Defense (U.S.)	14	14
Department of Defense (Overseas)	8	7
Atomic Energy Commission (U.S.)	1	1

The Interdepartmental Committee for Applied Meteorological Research, one of two interdepartmental committees which advise and assist the Federal Coordinator, has been charged with preparing a Federal plan for obtaining upper-air data above 100,000 feet. The Federal Coordinator has requested information from Federal agencies regarding their requirements for these data and their future plans in this area.





Air Force reconnaissance photo of Hurricane Betsy (1965).

WEATHER RECONNAISSANCE OBSERVATIONS

The Department of Defense aircraft weather-reconnaissance program requires FY–68 funds in the amount of $18,193,000, an increase of $709,000 from FY–67 funding.

Aircraft reconnaissance provides weather information at flight altitude along a continuous path, and instruments dropped from the aircraft supply data from flight altitude to the earth's surface at specified reporting points. This method of observation is used principally over ocean areas where there are few weather stations. Reconnaissance flights over the Atlantic, Pacific, and Arctic oceans provide essential data for basic analysis and forecasting, as well as for hurricane and typhoon forecasting. There have been substantial increases in the military weather-reconnaissance effort to meet Department of Commerce requirements for additional observations to improve hurricane and storm warnings for the Atlantic, Gulf of Mexico, and Pacific coasts of the United States. As a result, FY–67 expenditures have risen approximately $3,900,000 over costs shown in the FY–67 plan.

The effort devoted to weather reconnaissance is:

AGENCY	NUMBER OF AIRCRAFT FY-67	NUMBER OF AIRCRAFT FY-68
Department of Defense (Navy)	6	5
Department of Defense (Air Force)	15	15

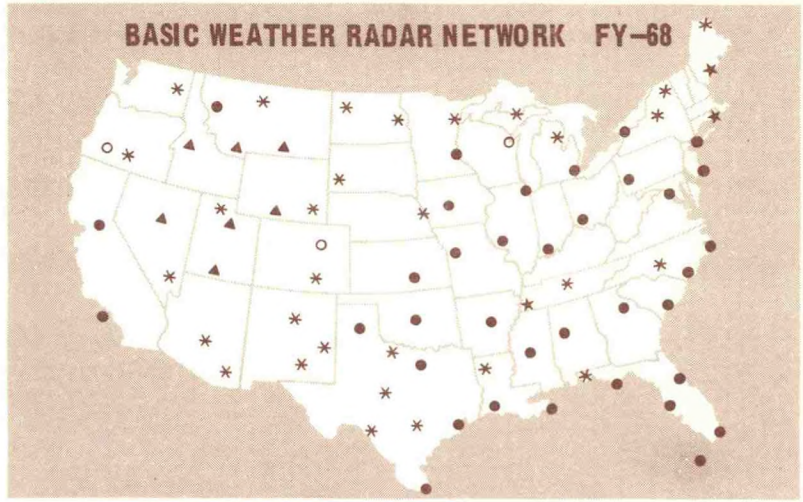
RADAR OBSERVATIONS

Weather radar observations planned for FY–68 require $7,796,000 of the Federal funds for weather observations. This represents a decrease of $167,000 over the Federal program for FY–67.

Specifically designed weather-surveillance radar vastly extends the area which can be observed from a single location and supplies vital information for public weather warnings and for short-range forecasts for airports and metropolitan areas. Day and night, the radar screen presents a continuous picture of the location and extent of rain, snow, and other important weather phenomena within a radius of approximately 100 miles. Radar has demonstrated its value most dramatically in hurricane and tornado tracking and has contributed greatly to the improvement of storm warnings. Radar reports are used extensively in aviation to brief pilots on severe storm areas. At military bases, weather radar provides information from which warnings of thunderstorms and severe weather can be prepared to protect personnel and equipment on the ground and aircraft in flight .

A Federal Plan for Weather Radars and Remote Displays, prepared under the auspices of the Federal Coordinator for Meteorological Services and Supporting Research, has determined the Federal need for local and network weather radar observations and established a coordinated long-term program to meet these needs most effectively and economically. The Basic Weather Radar Network, making detailed observations on a scheduled basis, is composed of Department of Commerce radars supplemented where technically and economically feasible by weather radars of the Department of Defense. Air Traffic Control radars of the Federal Aviation Agency are also used in the Rocky Mountain region to supply limited observations in an area where weather radar installations are extremely expensive and the occurrence of severe weather is relatively low. Observations from the network are collected at a central location, composited, and transmitted over facsimile systems to weather service offices for use in preparing forecasts, warnings, and pilot briefings beyond the range of their local radar coverage. The accompanying map displays the Basic Weather Radar Network proposed for FY–68. Principal network changes planned for FY–68 include operation of two additional radars by the Department of Commerce and transfer of three Navy radars to Commerce in order to make maximum use of Federal radar assets. The Department of Commerce also plans to procure three additional radars in FY–68 for operation in subsequent years. The Basic Weather Radar Network will change year by year as the participating agencies add modern weather radars to expand the coverage into additional areas and replace obsolete or unsuitable radars.

The Federal Plan for Weather Radars and Remote Displays also considers requirements for local-use radar information and the various means of meeting these requirements. Tests of remoting techniques indicate that many local-use



requirements can be met by remote displays from nearby weather radars. Installation of some new military radars has been held in abeyance pending completion of tests of remoting equipment and procedures. Use of remoting techniques in lieu of additional local-use radars avoids unwarranted duplication of radar coverage and could save the Federal government on the order of $50,000 in capital investment and $15,000 in annual operating costs at each location. Remote displays are programed at more than 90 locations through FY–67; 20 additional installations are planned for FY–68.

The weather radar observation program is summarized below. These figures do not include obsolete radars of limited range and usefulness, nor FAA air traffic control radars.

WEATHER RADAR OBSERVATIONS

AGENCY	OPERATIONAL LOCATIONS FY-67	FY-68
Department of Commerce (U.S.)	35	40
Department of Defense (U.S.)	73	100
Department of Defense (Overseas)	16	23
National Aeronautics and Space Administration (U.S.)	1	1

WEATHER SATELLITE OBSERVATIONS

Substantial Federal expenditures for weather observations are in the weather satellite program. For this reason, weather satellite observations and funding are discussed in detail in a separate section of this plan.

AGENCY OPERATIONAL COSTS BY TYPE OF OBSERVATION

	SURFACE OBSERVATIONS		UPPER AIR (BALLOON) OBSERVATIONS		UPPER AIR (ROCKET) OBSERVATIONS		WEATHER RECONNAISSANCE OBSERVATIONS		WEATHER RADAR OBSERVATIONS		WEATHER SATELLITE OBSERVATIONS		TOTAL	
	1967	1968	1967	1968	1967	1968	1967	1968	1967	1968	1967	1968	1967	1968
AIR FORCE	5,597	6,274	5,824	6,375	2,759	4,158	13,212	13,648	1,638	2,323	250	258	29,280	33,036
ARMY			4,785	4,785									4,785	4,785
AEC	215	218	290	292	250	250							755	760
COMMERCE	10,157	10,646	8,190	9,109					5,527	4,580	21,223	25,405	45,097	49,740
FAA	1,927	1,295											1,927	1,295
ICSC	75	75	367	426					125	150			567	651
NASA	221	98	249	222	89	64	102	350	25	32			686	766
NSF	121	120	200	200									321	320
NAVY	6,562	6,602	1,548	1,621	758	803	4,170	4,195	648	711	826	831	14,512	14,763
TREASURY	689	728	5,472	5,821									6,161	6,549
TOTAL	25,564	26,056	26,925	28,851	3,856	5,275	17,484	18,193	7,963	7,796	22,299	26,494	104,091	112,665

ANALYSES AND FORECASTS

The Federal agencies plan expenditures of $41,733,000 in FY–68 to meet their needs for weather analyses and forecasts. This represents an increase of $3,655,000 over FY–67 agency programs in this function.

Weather observations from the United States and around the world are collected at weather processing centers. Modern electronic computers and automatic data-processing equipment have made the preparation of many weather maps and forecasts an entirely automatic process. Central processing of weather observations allows agencies to concentrate their most highly skilled personnel and take advantage of the technical and economic benefits of computers. Centrally produced weather analyses and forecasts greatly reduce the need for manual plotting and analysis at each weather service office, thereby eliminating much duplication of effort.

There are three major types of analysis and forecast centers, i.e., primary, area and guidance, and specialized. Primary centers produce basic analyses and forecasts and provide basic warning services. Area and guidance centers supplement the products of primary centers and adapt them to their particular regions. Specialized centers serve unique requirements of specific user groups or provide a service not available from other centers such as climatological support.

PRIMARY CENTERS

ESSA operates four primary centers. The National Meteorological Center at Suitland, Md., provides basic weather analyses and forecasts for the Northern Hemisphere for Federal agencies and private interests. Its products are distributed by facsimile and teletypewriter to users in the United States and overseas. Approximately 575 facsimile and 200 teletypewriter transmissions are made daily to distribute the products prepared from the following typical observations received daily:

- ***37,000 surface observations of all types from land stations***
- ***1,400 surface observations from ships***
- ***1,500 upper-air observations***
- ***500 aircraft reports***
- ***All available cloud data from weather satellites.***

In addition to the foregoing activities, the National Meteorological Center has been designated as one of three World Meteorological Centers. This entails global responsibilities for analyses and forecasts under the World Weather Watch program.

A National Hurricane Center and a Tropical Analysis Center are operated in Miami, Fla., by ESSA. The Hurricane Center, operating seasonally, provides basic forecasts and warnings of hurricanes in the Atlantic, Caribbean, and Gulf of Mexico for all Federal agencies and user groups. The Tropical Analysis Center produces basic analysis and forecast information covering the tropical latitudes, supplementing the mid- and high-latitude products of the National Meteorological Center.

The National Severe Storms Forecast Center is operated at Kansas City, Mo., by ESSA to provide forecasts and warnings of severe local storms, including tornadoes, for the general public and most Federal agencies. A continuous watch of weather developments in the 48 contiguous states is maintained and alerts are issued when needed.

Department of Commerce responsibilities for establishing and operating

AGENCY OPERATIONAL COSTS BY TYPE OF CENTER

	PRIMARY CENTERS		AREA & GUIDANCE CENTERS		SPECIAL-IZED CENTERS		TOTAL	
	1967	1968	1967	1968	1967	1968	1967	1968
AIR FORCE	4,019	5,102	3,112	3,404	2,352	2,710	9,483	11,216
COMMERCE	7,078	8,336	8,291	8,453	7,416	7,480	22,785	24,269
NASA					579	605	579	605
NSF					30	0	30	0
NAVY	1,066	1,420	1,473	1,525	2,577	2,602	5,116	5,547
TREASURY					85	96	85	96
TOTAL	12,163	14,858	12,876	13,382	13,039	13,493	38,078	41,733

a National Operational Meteorological Satellite System are fulfilled by ESSA's National Environmental Satellite Center at Suitland, Md. The center, in addition to managing all operational meteorological satellite operations, processes data from operational and research and development meteorological satellites to provide outputs required by civil and military users. Sophisticated computer and photographic techniques are used for this purpose. Direct data interpretation is also carried on by highly skilled personnel to provide direct support to analysis and forecast centers. This work has made significant contributions to forecasts and warnings of hurricanes and other major storms by providing information on their existence and intensity in areas where conventional observations are sparse or non-existent.

The Department of Defense operates four primary centers to meet its specialized needs in the United States and overseas. The Air Force Global Weather Central at Offutt AFB. Nebr., provides basic analysis and forecast products in support of the worldwide aerospace operations of the Air Force. Its products are distributed to Department of Defense facilities in the United States and overseas on facsimile, teletypewriter and high-speed communications systems. Smaller Air Force Centers are operated at High Wycombe, England, and Fuchu, Japan, to provide basic products for distribution to Air Force units in Europe and the Far East. The Navy Fleet Numerical Weather Facility at Monterey, Calif., provides basic analysis and forecast products in support of naval forces at sea and on shore. Its products are distributed over Navy digital communications systems to Fleet Weather Centrals and Facilities throughout the world.

A number of major changes, particularly in computers and computer capability, are planned for FY–68. The Air Force plans to expand and modernize its computer systems at the Global Weather Central by replacing its present equipment with new, high-speed, large-capacity systems. These new computer systems will permit the Air Force to take advantage of recently developed analysis and forecast models and to increase the efficiency of the Center's operations.

The Navy plans to continue its program for expanding the computer capability of the Fleet Numerical Weather Facility by increasing computer memory capacity and peripheral equipment necessary to accommodate new analysis and forecast models.

AREA AND GUIDANCE CENTERS

Area and guidance centers form the intermediate level in the weather analysis and forecasting structure. These centers, using the products of primary centers, are responsible for forecasts and warnings within their assigned areas. They also provide detailed guidance and support to weather service offices within their areas.

The Department of Commerce operates 25 area and guidance centers. Each is responsible for forecasts and warnings for states or large portions of states for periods of 48 hours. Shorter-period warnings are issued to the public in hazardous weather situations.

The Department of Defense operates 10 area and guidance centers in the United States and 10 in overseas areas to meet military requirements. These centers operate much like their civil counterparts but primarily support major military command headquarters.

Efforts of the Interdepartmental Committee for Meteorological Services have resulted in a cooperative processing effort by the Departments of Commerce, Navy, and Air Force in Hawaii where each operates a center. Unnecessary duplication has been eliminated, and work is continuing to assure that future plans represent a fully coordinated Federal effort.

SPECIALIZED CENTERS

Specialized centers meet the unique requirements of a specific user group. Their personnel are trained in special areas such as agricultural, marine, and aviation meteorology to better understand and meet the needs of the users.

The Department of Commerce has specialized centers to serve aviation, agriculture, and fire-weather activities. These are small units, usually co-located with the larger area centers, producing tailored information for their users. Department of Defense agencies operate 7 specialized centers in the United States and 5 in overseas areas to meet military needs. These centers provide tailored support to specific types of military activities such as airlift and fleet operations. Additionally, the National Aeronautics and Space Administration contracts with the Department of Commerce for small, highly specialized centers to support the space program at 6 locations in the United States. The National Science Foundation contributes funds to an international program for an Antarctic analysis center.

The Department of Commerce operates the National Weather Records Center at Asheville, N.C., as the central archiving, processing, and service center for weather records collected by all Federal agencies. Business organizations and private citizens, as well as foreign governments, obtain climatological support for design and operational activities from this center. A co-located processing activity is operated by the Air Force to meet its requirements, and the Navy maintains a small liaison staff. A committee chaired by the Office of the Federal Coordinator for Meteorological Services and Supporting Research was established to plan for selection and installation of a new joint computer facility at the National Weather Records Center. Detailed plans and agreements were developed for specifications, selection, installation, management, and cost sharing of the new system. A Request for Proposals has been issued to industry for a computer system to be installed in FY–68.

COMMUNICATIONS

Weather communications networks are coordinated and planned by the National Communications System, with the advice and assistance of Federal agencies. The Federal Coordinator for Meteorological Services and Supporting Research is represented on a National Communications System working group charged with reviewing, coordinating, and planning overseas weather communications to minimize data redundancy and avoid unwarranted duplication of system channels.

Expenditures for communications require approximately 16 percent of the funds budgeted for meteorological services. The Federal agencies plan expenditures of $50,197,000 in FY–68 for weather communications of all types. This represents a decrease of $3,172,000 from the FY–67 programs for this function.

Rapid, reliable communications systems are an essential part of the Federal Government's meteorological services. Demands for service created by the increasing ranges and speed of modern civil and military aircraft require collection and exchange of observations from most areas of the world for operational uses, as well as for inputs into the analysis and forecasting routines at weather centers. The products of the Basic and Specialized Services must be delivered over effective, reliable communications systems so that their full economic and safety benefits may be realized by the public and user groups.

Teletypewriter systems have, for many years, been the principal means of collecting and exchanging observations, and facsimile systems are used widely to distribute weather maps and other products from weather centers. The demands for increased amounts of data, greater collection speed, and more products from computers in weather centers have forced the Federal agencies to use new high-speed digital systems for certain teletypewriter and facsimile networks.

Voice systems (including telephone-answering devices and radio), telescribers, and closed-circuit television are used extensively in local operations to disseminate information to users.

TELETYPEWRITER

Teletypewriter Services A, C, and O, operated by the Federal Aviation Agency are the principal civil systems within the United States. These are supplemented by the Department of Commerce Radar Reporting and Warning Coordination System. Statewide Teletypewriter Networks, and circuits to collect and disseminate information for specialized user groups. The Department of Defense uses three teletypewriter systems operated by the Air Force—COMET I, II, and III—to meet its needs in the United States. Requirements which cannot be met by these systems are served by special-purpose systems.

Teletypewriter systems operated by the Federal Aviation Agency meet United States' commitments for support to international civil aviation. In January 1967 the Department of Commerce began operation of a high-speed digital circuit between Suitland, Maryland and Offenbach, Germany to collect and exchange meteorological data internationally as part of the World Weather Watch System. Additional circuits are planned. The Department of Defense also operates a high-speed digital system to collect data from overseas areas as an input to the military command and control systems and for use in its weather centers.

Major additions and improvements in teletypewriter systems are planned for FY–68. The majority of these are continuations of long-term programs initiated in prior years. The Federal Aviation Agency program to modernize Services A, C, and O will continue with installation of a computer-operated switching center in Kansas City, funded in prior years. Terminal equipment improvements are planned at a number of locations using FY–68 funds. The Department of Commerce plans to expand its international data exchange with South America and add exchanges across the Pacific to Japan. In addition, the statewide teletypewriter systems used to distribute national disaster warnings and other products will be expanded into 11 additional areas. The Air Force plans to add computer equipment at a number of terminals on its Automated Weather Network to provide for direct inputs to command and control systems and to its computers at weather analysis and forecast centers.

FACSIMILE

The Department of Commerce operates the National Facsimile Network to distribute basic analyses and forecasts to all Federal agencies and public users in the United States. This network with approximately 750 Government and private terminals is supplemented by a High-Altitude Facsimile Network which distributes specialized aviation-oriented products and a Forecast Center Facsimile Network which links the National Meteorological Center with other Department of Commerce analysis and forecast centers. The Department of Defense uses the civil systems and operates a Strategic Facsimile Network in the United States to meet its specialized needs.

Products of the analysis and forecast centers are also exchanged internationally as part of the World Weather Watch over Department of Commerce systems and by radio-facsimile broadcasts operated by the Federal Aviation Agency. Department of Defense agencies distribute products to their overseas weather centers and offices via their own systems.

The Department of Commerce plans to establish radio-facsimile broadcasts on the east and west coasts of the United States in FY–68 to provide service to merchant vessels, the fishing fleets, and other marine users. The Air Force plans to procure new high-speed digital facsimile equipment for the Strategic Facsimile Network in FY–67. This equipment is programed for delivery and installation in FY–69 and 70.

AGENCY OPERATIONAL COST BY TYPE OF COMMUNICATION

	TELETYPE-WRITER		FACSIMILE		VOICE TELESCRIBER & TELEVISION		TOTAL	
	1967	1968	1967	1968	1967	1968	1967	1968
AIR FORCE	17,057	18,307	5,418	2,412	3,411	1,030	25,886	21,749
AEC	15	20	15	15	25	25	55	60
COMMERCE	2,896	3,810	1,900	1,900	890	1,005	5,686	6,715
FAA	12,160	12,225	190	370	3,787	3,363	16,137	15,958
ICSC	4	6			4	5	8	11
NASA	58	63	67	75	80	88	205	226
NAVY	3,875	3,757	1,195	1,301	150	240	5,220	5,298
TREASURY	35	37	37	39	100	104	172	180
TOTAL	36,100	38,225	8,822	6,112	8,447	5,860	53,369	50,197

VOICE, TELESCRIBER, AND TELEVISION

Voice communications systems have a major role in meteorological services. Weather information is disseminated to the general public through telephones and telephone-answering recorders. Use of these recorders for distribution of weather information to aviation, marine, and other specialized groups is increasing, thus allowing a growing number of users to be served at minimum expense. Recorded radio broadcasts of weather observations, forecasts, and warnings for aviation uses are provided by the Federal Aviation Agency. The Department of Commerce is making increasing use of recorded FM radio broadcasts and warnings to the general public and small-craft operators under the developing Natural Disaster Warning System. FM radio systems are also being used as emergency communications links between essential Department of Commerce facilities in areas of high incidence of hurricanes and severe storms which frequently disrupt normal communications. The Department of Defense operates 111 two-way radio stations in the United States for direct voice contacts between airborne pilots and forecasters.

Telescriber systems are used at many civil and military airfields to distribute observations, forecasts, and warnings to air traffic controllers, aircraft operations offices, and other users. Closed-circuit television is coming into use by the Defense agencies to distribute this type of information and to provide weather briefings for pilots and control personnel. Sixty-six sets of closed circuit television are being procured in FY-67 and 18 sets in FY–68 by the Air Force.

The Department of Commerce plans to buy and install additional FM radio equipment in FY–68 for emergency communications, and the Federal Aviation Agency plans to begin converting its telescriber equipment from leased to Government-owned as a means of reducing long-term Federal costs.

DISSEMINATION TO USERS

The Federal agencies plan expenditures in the amount of $47,869,000 in FY–68 for dissemination of weather products to users. This represents an increase of $1,824,000 over the FY–67 agency programs in this functional area.

After weather observations have been collected and processed, the products must be presented to the general public or user group for whom the service is designed. Processed weather information from analysis and forecast centers must be adapted to local conditions and interpreted to emphasize the weather elements of concern to the general public and specialized users. This final step in the production of meteorological services is accomplished in civil and military weather service offices and flight service stations. The products are conveyed to their consumers by personal briefings in the weather service offices and flight service stations; by communications devices such as telephones, telephone answering recorders, and recorded broadcasts; and by coastal warning and display systems. Civil weather service offices provide up-to-date information to newspapers and radio and television stations as the principal means of reaching the general public.

WEATHER SERVICE OFFICES

The Department of Commerce has 254 weather service offices which provide forecasts and warnings to the general public and to responsible State and local officials. Many of these offices have been supplemented with specially trained personnel to provide weather information for aviation, agriculture, fire-weather, and other specialized user groups. A few Department of Commerce weather service offices are operated solely to provide weather information for specialized users when dictated by technical or economic considerations.

The Department of Defense operates 442 weather service offices including facilities on land and on board ship, furnishing forecasting, briefing, climatological, and consultant services to military units. Department of Defense mobile units provide weather support for maneuvers, exercises, and special military operations.

FLIGHT SERVICE STATIONS

The Federal Aviation Agency's network of Flight Service Stations provides a major outlet for weather information to aviation interests. Aviation weather briefing services by the Federal Aviation Agency are available from 333 Flight Service Stations on civil airports. Many of these facilities also provide weather briefing services over telephone systems to pilots at smaller airports

AGENCY OPERATIONAL COSTS BY TYPE OF DISSEMINATION TO USERS

	WEATHER SERVICE OFFICES		FAA STATIONS		COASTAL WARNING & DISPLAY		TOTAL	
	1967	1968	1967	1968	1967	1968	1967	1968
AIR FORCE	27,504	27,910					27,504	27,910
AEC	234	245					234	245
COMMERCE	12,471	13,062			53	518	12,524	13,580
FAA			1,144	1,328			1,144	1,328
ICSC	48	62					48	62
NASA	26	31					26	31
NAVY	4,539	4,683					4,539	4,683
TREASURY					26	30	26	30
TOTAL	44,822	45,993	1,144	1,328	79	548	46,045	47,869

with no other weather information source. Some airports have both a Flight Service Station and a Department of Commerce weather office. In these cases, the Flight Service Station handles the routine briefings; requests requiring a professional meteorologist are referred to the Department of Commerce weather office.

COASTAL WARNING AND DISPLAY

The Departments of Commerce and Treasury cooperate in operating a coastal warning and display system to warn pleasure boatmen, and other marine interests lacking radio-receiving equipment, of impending weather conditions on coastal and inland waters. Many yacht clubs, marinas, and other private as well as state and local marine interests also participate in this system. More than 550 flag or light displays are operated along the seacoasts, the shores of the Great Lakes, and inland waterways. The Department of Commerce operates 75 displays, and the Department of Treasury operates 163. State, local, and private interests operate the remainder.

GENERAL AGENCY SUPPORT

The Federal agencies plan expenditures of $65,480,000 in FY–68 for general agency support of meteorological activities. This represents an increase of $4,434,000 over FY–67 agency programs in this functional area.

General agency support covers activities which agencies must carry on in order to operate effective meteorological service programs. It includes four sub-categories: Internal Support; Training; Maintenance; and Management Above Operating Level.

INTERNAL SUPPORT

General mission-related activities in support of meteorological operations within an agency are necessary parts of providing service to users. These activities include the following types of programs:

- ***Engineering support for planning, preparing specifications, surveying equipment sites for suitability, inspecting and calibrating new equipment.***
- ***Scientific studies, services, and consultants to determine feasibility of new programs and to increase the effectiveness of on-going programs.***
- ***Quality control of products to assure that standards for accuracy and productivity are maintained.***
- ***Employee housing and housekeeping or utility-type equipment at remote area locations.***

The principal changes planned in FY–68 for Internal Support are Department of Commerce programs to construct family housing at a Pacific Trust Territory station, to replace worn out utility equipment at Arctic Cooperative stations and to expand weather observation quality-control activities. In addition, an expenditure is planned for engineering support associated with procuring, installing, and calibrating new equipment for the Natural Disaster Warning System.

TRAINING

Technical training of personnel is an essential part of developing and maintaining effective, efficient meteorological services. Training in the various specialties is conducted in Federally operated schools and in colleges and universities. Generally, training in weather observations, communications, maintenance, and similar technician-level skills is accomplished in schools operated by the agencies; professional-level training is obtained by attendance at accredited colleges and universities. Training costs include instructor and student pay, equipment, travel, books, and tuition.

The major portion of the Federal training effort is carried out by the Department of Defense agencies to meet military requirements. Technician-level training is conducted in Air Force, Navy, and Army schools. The majority of meteorological specialty training is conducted at four locations—Chanute Air Force Base, Ill., for Air Force personnel; Lakehurst Naval Air Station, N. J., for Navy personnel; and Fort Sill, Okla., and Fort Monmouth, N. J., for Army personnel. Basic and advanced skills in meteorological specialties are acquired by students at these schools. The Air Force and Army utilize colleges and universities for both basic and advanced training of their professional-level personnel. The Navy, however, provides professional-level training at its Post-Graduate School and uses colleges or university training only for special or advanced degree work. Many personnel trained under these Department of Defense programs become available to the civilian agencies once they have completed their military obligations.

The Department of Commerce operates the National Meteorological Maintenance Training Center at Kansas City to provide equipment maintenance technician training. Professional-level training is obtained through colleges and universities or in programs operated by other Federal agencies. The Federal Aviation Agency's Academy at Oklahoma City provides the meteorological training required for that agency's air traffic control personnel as well as technician training on weather communications equipment.

Training costs in FY–67 were substantially higher than indicated in the Plan for that year due to considerable increases in Department of Defense training efforts to meet the requirements of military operations in Southeast Asia. The Air Force plans an additional $730,000 expenditure for further expansion of its training program in FY–68.

MAINTENANCE

Continuing maintenance is necessary to keep meteorological equipment in proper operating condition. Maintenance costs include salaries, travel, test equipment, and spare or replacement parts for meteorological equipment. All maintenance costs for weather reconnaissance aircraft and communications systems are included in the costs shown for these programs in preceding sections.

Maintenance is performed in central overhaul facilities, regional shops, and local shops. The majority of the maintenance effort is carried on at the local level, where emphasis is on preventive maintenance and swift emergency actions to restore vital facilities to operation. This is of special importance when these facilities support critical operations—surface observations at airfields, for example, or weather radars for warning of impending hazardous weather conditions. Safety of life and property requires continuing preventive maintenance to assure that these facilities are operating properly and prompt corrective maintenance to return them to operation when they fail.

AGENCY OPERATIONAL COSTS BY TYPE OF GENERAL AGENCY SUPPORT

	INTERNAL SUPPORT		TRAINING		MAINTENANCE		MANAGEMENT ABOVE OPERATING LEVEL		TOTAL	
	1967	1968	1967	1968	1967	1968	1967	1968	1967	1968
AIR FORCE	1,698	1,930	15,400	16,130	6,386	7,868	5,816	6,159	29,300	32,087
ARMY			1,135	1,249			34	34	1,169	1,283
AEC	104	120	8	8	218	226	55	58	385	412
COMMERCE	2,711	2,919	432	441	6,471	7,565	6,461	6,078	16,075	17,003
FAA	1,228	1,250	358	188	798	1,714	1,833	1,985	4,217	5,137
ICSC	374	222	10	10	60	70	17	11	461	313
NASA	49	57	30	27	50	70	127	138	256	292
NAVY	1,563	1,603	4,246	3,796	2,432	2,542	918	994	9,159	8,935
TREASURY			10	10			8	8	18	18
TOTAL	7,727	8,101	21,629	21,859	16,415	20,055	15,269	15,465	61,040	65,480

Agencies operate central overhaul facilities where major repair or rebuilding operations are carried out on entire items or on major components of equipment. Three central overhaul facilities are operated by the Department of Defense, and one is operated by the Department of Commerce.

Regional maintenance facilities are operated by the Department of Defense to furnish technical assistance to the local maintenance shops and perform those preventive and corrective maintenance actions which are beyond the capability of the local shops.

Maintenance costs have risen steadily over past years, reflecting the additional effort required to keep increasing amounts of complex equipment in proper operating condition. The Department of Commerce plans increased expenditures of $800,000 in FY–68 to expand its maintenance activities. This expansion is the beginning of a multi-year program to increase its maintenance activities to the level required by equipment recently installed or under procurement. The FAA increase reflects its assumption of maintenance responsibility from Commerce for runway visual range equipment. The Air Force increase is for procurement of spare parts for new weather radars and an increase in maintenance personnel.

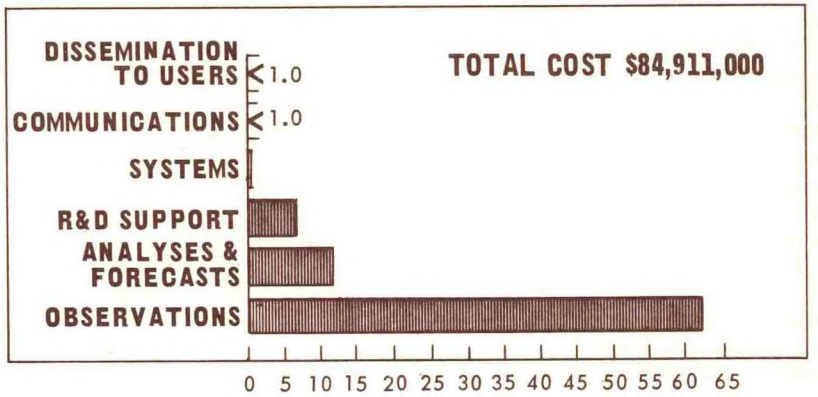
MANAGEMENT ABOVE OPERATING LEVEL

Management, supervision, administration, and logistic support are considered an integral part of units at the operating level; however, a certain amount of executive management, administration, and logistic support must come from higher echelons. In general, management above operating unit level is confined to civil agency headquarters and regional offices and to similar headquarters in the military agencies.

SUPPORTING RESEARCH
A FUNCTIONAL DESCRIPTION

The section of this plan which discusses the Basic Meteorological Service and each of the specialized meteorological services presents Federal research programs in terms of their contribution to the improvement of each of these services. Since a research program designed to improve a particular meteorological service is often similar in objective to one designed to improve another meteorological service, it is desirable to view the totality of the Federal program for research in support of improved meteorological services along functional lines. Accordingly, in this section of the plan, the total supporting research program is categorized by function: Observations; Analyses and Forecasts; Communications: Dissemination to Users; Systems; and Research and Development Support. With the exception of Research and Development Support, these functional categories are the same as were used in the FY–67 version of this plan. Research and Development Support includes

DISTRIBUTION OF SUPPORTING RESEARCH COSTS BY FUNCTION, FY-68



AGENCY SUPPORTING RESEARCH COSTS BY FUNCTION

	OBSERVATIONS		ANALYSES & FORECASTS		COMMUNICATIONS		DISSEMINATION TO USERS		SYSTEMS		R&D SUPPORT		TOTAL	
	1967	1968	1967	1968	1967	1968	1967	1968	1967	1968	1967	1968	1967	1968
AGRICULTURE	186	186	1,031	1,059									1,217	1,245
AIR FORCE	3,848	3,161	2,275	1,899	1		3		151	274			6,278	5,334
ARMY	3,385	5,895	1,588	1,770							4,960	5,150	9,933	12,815
AEC			862	880									862	880
COMMERCE	1,572	1,340	3,355	3,936			29	25	827	1,280	1,365	1,365	7,148	7,946
FAA	438	1,322	341		238	204							1,017	1,526
HEW			1,005	1,038							269	412	1,274	1,450
NASA	35,084	50,780	1,125	1,370			50						36,259	52,150
NAVY	835	885	680	680									1,515	1,565
TOTAL	45,348	63,569	12,262	12,632	239	204	82	25	978	1,554	6,594	6,927	65,503	84,911

those Research and Development funds which are used to provide meteorological support to research, development, test, and evaluation activities. The funds included in this category in this plan were spread among the other four functions in the FY–67 version.

During FY–67 the Federal Coordinator initiated a study of the total Federal needs for improvements in meteorological services which can be met only after further supporting research. Information requested of the agencies has now been received and is being reviewed and consolidated. In some instances, it has been necessary to request additional data in order to obtain uniform and comparable statements of agency needs. The objective of this study is to assist the Federal Coordinator in assessing the adequacy and balance of future Federal plans for supporting research.

For FY–68, supporting research projects totaling 84,911,000 are planned by nine agencies, an increase of 19,408,000 over FY–67. These projects represent 59 percent of the total Federal expenditure of $140,010,000 on meteorological research planned for FY–68 as reported to the Interdepartmental Committee for Atmospheric Sciences of the Federal Council for Science and Technology. The remaining 41 percent is for basic research in meteorology which is not under the purview of the Federal Coordinator. All meteorological research is related in some degree to the improvement of meteorological services. Many meteorological service deficiencies, however, cannot be remedied except through basic research in meteorology necessary to acquire increased understanding of pertinent atmospheric processes. Such projects are not included in the Federal Plan, although they will ultimately produce improvements in meteorological services.

Planned FY–68 Federal expenditures for supporting research projects in each of these functional areas are presented in the bar chart. Funds indicated for communications involve only projects leading to improvement of local means for transmitting weather information and do not include efforts to improve long-line weather teletypewriter and facsimile communications.

The distribution of agency funds for supporting research among the functions is also presented in table form to show changes in the funding pattern from FY–67 to FY–68.

OBSERVATIONS

DEVICES TO MEASURE SPECIFIC WEATHER ELEMENTS

These are measuring devices in various stages of research and development, such as barometers, thermometers, wind sensing equipment, humidity sensors and visibility meters. Special studies are in progress by the Federal Coordinator to provide additional details on research on wind and density sensors, with a view toward possible merging of research and development activity if agency requirements indicate an acceptable degree of similarity. The level of research effort on these devices shows an increase due to expanded FAA work in visibility sensors, which more than offsets a decrease in Air Force effort in the general field of sensors.

DATA PREPROCESSORS

The level of effort in this area is small. The Army is developing specialized computers for observations from mobile land stations, and the Navy is developing a cloud height computer indicator.

DIRECT SENSOR SYSTEMS

The Department of Defense will increase its efforts to develop sensor systems for support of the Southeast Asia effort. The increase applies to the procurement of test models of equipment which has reached the engineering stage. NASA and Department of Commerce efforts are aimed at improved upper air sounding systems. The Federal Coordinator is currently engaged in a special study of all upper-air sounding systems being developed (both balloon- and rocket-borne) to determine the need for system improvements and the most efficient and effective way to achieve them.

INDIRECT SENSOR SYSTEMS

Projects in this area include supporting research on weather radars, lasers, and instrumentation for measuring meteorological quantities by indirect means. Radar is the subject of still another on-going study by the Federal Coordinator. Projects in the radar research area include precipitation, lighting, and storm tracking; development of mobile equipment and Doppler devices; and studies in the use of radar to aid in maintaining a higher level of safety in air traffic control. Use of radar and the laser principle to detect cloud height and clear air turbulence is in the development stage.

AGENCY SUPPORTING RESEARCH COSTS BY OBSERVATIONS SUBFUNCTION

	DEVICES TO MEA. SPECIFIC WEA. ELEMENTS		DATA PREPROCESSORS		DIRECT SENSOR SYSTEMS		INDIRECT SENSOR SYSTEMS		OBSERVATION PLATFORMS AND POWER SUPPLIES		TOTAL	
	1967	1968	1967	1968	1967	1968	1967	1968	1967	1968	1967	1968
AGRICULTURE	186	186									186	186
AIR FORCE	2,024	1,369			448	500	1,286	1,292	90		3,848	3,161
ARMY	115	115		80	2,325	5,150	620	360	325	190	3,385	5,895
COMMERCE	126	188			408	405	413	412	625	335	1,572	1,340
FAA	427	1,221			10	84	1	17			438	1,322
NASA	386	525			840	810	295	120	33,563	49,325	35,084	50,780
NAVY	25	25	25	25	575	575	60	60	150	200	835	885
TOTAL	3,289	3,629	25	105	4,606	7,524	2,675	2,261	34,753	50,050	45,348	63,569

OBSERVATION PLATFORMS AND POWER SUPPLIES

Research in this area includes projects in weather satellites and projects for the development of improved and cheaper materials for radiosonde balloons, new balloon configurations, and hydrogen-generating devices. The only significant increase is by NASA for weather satellites. Funding for satellites is covered in detail in the weather satellite section of this plan.

ANALYSES AND FORECASTS

ANALYSES

These are projects to develop and improve techniques for processing weather observations from many geographical points in order to map general weather configurations over wide areas. Also included are the development of techniques for extrapolating information from one level in the atmosphere to another and the development of computer programs for processing and analyzing meteorological data.

The greatest single area of effort is on improvement of upper-air analysis in the region from 40,000 to 150,000 feet. For levels below 40,000 feet, the Department of Commerce and NASA plan to increase effort on the utilization of satellite data for cloud and general weather analysis. Additional work is also planned on development of severe local storm models by the Department of Commerce.

During the next few months, the Federal Coordinator will make a special survey and report on interagency efforts to improve analysis techniques, including those efforts being undertaken by operational units.

FORECASTS

Forecast research projects include development of techniques for short- and extended-period forecasting to improve the Basic Meteorological Service and to meet the unique requirements of the specialized services, such as terminal forecasts for aviation and fire-weather forecasts for the forestry industry and park service. Most of the effort in this area is directed at the

development of numerical and statistical forecasting techniques. Many of the projects, if successful in producing improved forecasts in one area (e.g., air pollution), will have application in another (e.g., fire weather). Development of techniques of forecasting for the upper troposphere and stratosphere is being conducted largely by the Department of Defense. The principal FY–68 increase is for the Department of Commerce development of improved techniques for severe local storm forecasts, prediction of hurricane development and motion, and prediction of clear air turbulence. The FAA shows a substantial decrease in this area.

CLIMATOLOGY

Climatology, the study of series of past weather observations, involves collection, processing, analysis, synthesis, interpretation, and presentation of data. The research projects in this area cover studies of the state of the atmosphere, optimum display methods, bioclimatology, and the use of climatological data in operational decisions and engineering design.

Most projects are aimed at developing climatological data for specific problems of design or planning. Considerable effort is being applied to decision-making processes in such diverse fields as flight-route planning, space-vehicle design, fire-protection, air pollution, ballistics, etc. For example, the relationships of weather to health, crop production, plant diseases, and phenology are under investigation. The Department of Agriculture is continuing its significant level of effort on such studies. The Department of Defense is studying the climates of special problem areas, such as wet-tropical or polar, where materiel requirements are largely dependent on environmental influences. The Department of Health, Education and Welfare is concerned with climatological aspects of air pollution.

SUPPORT

This includes all miscellaneous projects relating to processing of meteorological data as it involves computer methods and data inputs to computers. This category also includes projects relating to two or more of the other subfunctions, such as the climatology and forecasting of hurricanes, as well as projects which did not fit clearly into one of the first three subfunctions, such as boundary layer and diffusion studies relating to air pollution or to weather radar information for severe storms. The total effort on such projects is essentially the same as in the previous year.

AGENCY SUPPORTING RESEARCH COSTS BY ANALYSES AND FORECASTS SUBFUNCTION

	ANALYSES		FORECASTS		CLIMATOLOGY		SUPPORT		TOTAL	
	1967	1968	1967	1968	1967	1968	1967	1968	1967	1968
AGRICULTURE					901	929	130	130	1,031	1,059
AIR FORCE	462	400	272	200	796	854	745	445	2,275	1,899
ARMY	250	250			362	380	976	1,140	1,588	1,770
AEC			862	880					862	880
COMMERCE	1,103	1,273	1,354	1,642	379	449	519	572	3,355	3,936
FAA			341						341	
HEW	49	49	169	175	247	254	540	560	1,005	1,038
NASA	541	855			374	475	210	40	1,125	1,370
NAVY	289	289	337	337	4	4	50	50	680	680
TOTAL	2,694	3,116	3,335	3,234	3,063	3,345	3,170	2,937	12,262	12,632

COMMUNICATIONS

WEATHER BROADCAST TRANSMISSION

The Department of Defense has essentially completed the development of a device for automatic conversion of weather data from digital to voice form, in order to speed dissemination of local operational weather information to pilots. No other work is planned in this area for FY–68.

TRANSMISSION OF RADAR INFORMATION

The Federal Aviation Agency is continuing a program to provide Air Route Traffic Controllers with better and more up-to-date weather information. Progress is being made in the processing of ATC radar returns for the transmission of weather echo intensity information over voice quality lines, and for the display of weather data in contour format on the controllers' scopes.

AGENCY SUPPORTING RESEARCH COSTS BY COMMUNICATIONS SUBFUNCTION

	WEATHER BROADCAST TRANSMISSION		TRANSMISSION OF RADAR INFORMATION		TOTAL	
	1967	1968	1967	1968	1967	1968
AIR FORCE	1				1	
FAA			238	204	238	204
TOTAL	1		238	204	239	204

DISSEMINATION OF USERS

LIMITED DATA DISPLAYS

The Department of Commerce is studying consolidated displays of local observational data at individual locations. The Department of Defense has no efforts planned in this area for FY–68 and is completing its FY–67 efforts concerned with testing high-speed page printers as applied to the meteorological display problem. The NASA effort, for FY–67 only, consists of developing an improved, ground-based facsimile recorder for displaying satellite information.

EXTENSIVE DATA DISPLAYS

The Department of Commerce is completing a study of a display system for the National Meteorological Center to monitor the manual production of large volumes of meteorological charts.

AGENCY SUPPORTING RESEARCH COSTS BY DISSEMINATION TO USERS SUBFUNCTION

	LIMITED DATA DISPLAYS		EXTENSIVE DATA DISPLAYS		TOTAL	
	1967	1968	1967	1968	1967	1968
AIR FORCE	3				3	
COMMERCE	20	25	9		29	25
NASA	50				50	
TOTAL	73	25	9		82	25

SYSTEMS

WORLD WEATHER WATCH

The Department of Commerce is preparing studies related to United States participation in the World Weather Program for the World Meteorological Organization. These studies include the design of global data observing, processing, and communications subsystems. An Optimum Meteorological Network study is concerned with determining, within the framework of global requirements for meteorological observations: (1) the feasibility of using merchant ships as upper air sounding platforms to bring about interim improvements; and (2) the technical and economic feasibility of a system of satellite-tracked balloons, floating horizontally in the atmosphere, as a longer-term solution.

DOMESTIC SERVICE PLANNING AND DESIGN STUDIES

The Department of Commerce is conducting a series of systems studies for the improvement of meteorological services. A pilot study of the weather service requirements of urban areas will assist in designing an urban weather service, including air pollution prediction. Another study is concerned with the provision of more accurate and timely warnings of tornadoes and severe storms. A design study of the optimum aviation forecast organization will provide the basis for an improved aviation weather system. A number of similar, user-oriented systems studies have been completed and will be updated as required.

RADAR SYSTEM IMPROVEMENT

Systematic studies of radar measurement accuracies are being expanded by the Department of Defense to include data processing and display and the potential of Doppler techniques.

RESEARCH AND DEVELOPMENT SUPPORT

Meteorological support to research, development, test, and evaluation activities of the agencies is generally financed under supporting research funds. This group of projects includes Department of Defense support to research and test facilities, Department of Commerce support to its Research Flight Facility at Miami, and Department of Health, Education and Welfare support to its Division of Air Pollution.

AGENCY SUPPORTING RESEARCH COSTS BY SYSTEMS SUBFUNCTION

	WORLD WEATHER WATCH		DOMESTIC SERVICE PLANNING AND DESIGN STUDIES		RADAR SYSTEMS IMPROVEMENT		TOTAL	
	1967	1968	1967	1968	1967	1968	1967	1968
AIR FORCE					151	274	151	274
COMMERCE	646	1,025	181	255			827	1,280
TOTAL	646	1,025	181	255	151	274	978	1,554

These photos were all taken from the same point at 22,300 miles above the earth by the Applications Technology Satellite–I. All times shown are in Eastern Standard Time. Together they show the changing cloud pattern over one half of the globe for an entire day. The Goddard Space Flight Center manages the ATS program for NASA.

WEATHER SATELLITES

SIGNIFICANT ACCOMPLISHMENTS SINCE JULY 1, 1965

FLIGHT PROGRAMS

TIROS X was launched on July 2, 1965, to insure coverage during the impending hurricane season. It was the last spacecraft of the original TIROS configuration, in which the camera axis is parallel to the spin axis. This spacecraft was placed in a sun-synchronous polar orbit, 459 miles high, with its spin axis in the plane of the orbit and perpendicular to the earth at approximately 25° North latitude. This arrangement resulted in excellent coverage of the hurricane areas from approximately 5° South latitude to 55° North latitude.

On February 3, 1966, the first Environmental Survey Satellite (ESSA 1) was launched. A modified TIROS spacecraft, it was placed in a near-polar, sun-synchronous orbit at a mean altitude of 478 miles above the earth. ESSA 1 operates in the cartwheel mode successfully proven with the earlier TIROS IX. In this mode, the satellite spins as it moves along its orbit, and the cameras mounted on the rim of the spacecraft take pictures when pointed downward at the earth below. ESSA 1 provided an operational system giving global cloud cover pictures on a daily basis.

ESSA 1 was followed by the successful launch of ESSA 2 on February 28, 1966. This satellite was significantly different from those which preceded it. It was placed in a near-polar orbit at a height of 860 miles, considerably higher than the altitudes of prior meteorological satellites. ESSA 2, like ESSA 1, uses the cartwheel mode. It has two 1-inch Automatic Picture Transmission (APT) cameras mounted on the rim of the spacecraft. The cameras take pictures when pointed straight downward at the earth below and send them by slow-scan television to simple, relatively inexpensive receivers within radio range—approximately 2000 miles—of the spacecraft. Engineering advances made in the spacecraft systems have fulfilled their promises of a significantly longer useful lifetime for ESSA 2.

The basic objectives of the TIROS Operational Satellite (TOS) System and the interim objectives of the National Operational Meteorological Satellite (NOMS) System were met when ESSA 2 joined ESSA 1 in orbit. The system provides cloud pictures of the entire sunlit portions of the earth twice each day. ESSA 2 takes and transmits APT pictures as it passes overhead during

local mid-morning, and ESSA 1 collects data globally during the local afternoon hours.

In May 1966, the second Nimbus R&D spacecraft (Nimbus II) was launched by the National Aeronautics and Space Administration and has been operating successfully. It carried the tvpe of sensors previously flown on Nimbus I, plus some new experiments. The original sensors consisted of the Advanced Vidicon Camera System (AVCS), the Automatic Picture Transmission (APT) System, and the High Resolution Infrared Radiometer (HRIR). The most important new experiment was the Medium Resolution Infrared Radiometer (MRIR) covering five spectral bands.

The water-vapor absorption band, at 6.4 to 6.9 microns, provides information about the upper limit of the water vapor concentration. The energy observed in this channel reflects the specific humidity of the atmosphere.

The atmospheric window measures the temperature of the earth and cloud tops in the 10- to 11-micron band where the atmosphere is transparent. These measurements provide information on the earth's surface temperature and radiation in the lower atmosphere. In addition, maps showing isolines of radiant emittance can be interpreted as cloud-cover maps, offering a limited backup to TV and HRIR measurements.

The carbon dioxide absorption band, 14 to 16 microns, responds primarily to the radiation of carbon dioxide and provides a measure of stratospheric temperature.

Terrestrial radiation covers the range of thermal emission from the earth (5 to 30 microns), permitting a study of the energy budget of the earth through measurements of the earth's total longwave infrared emission.

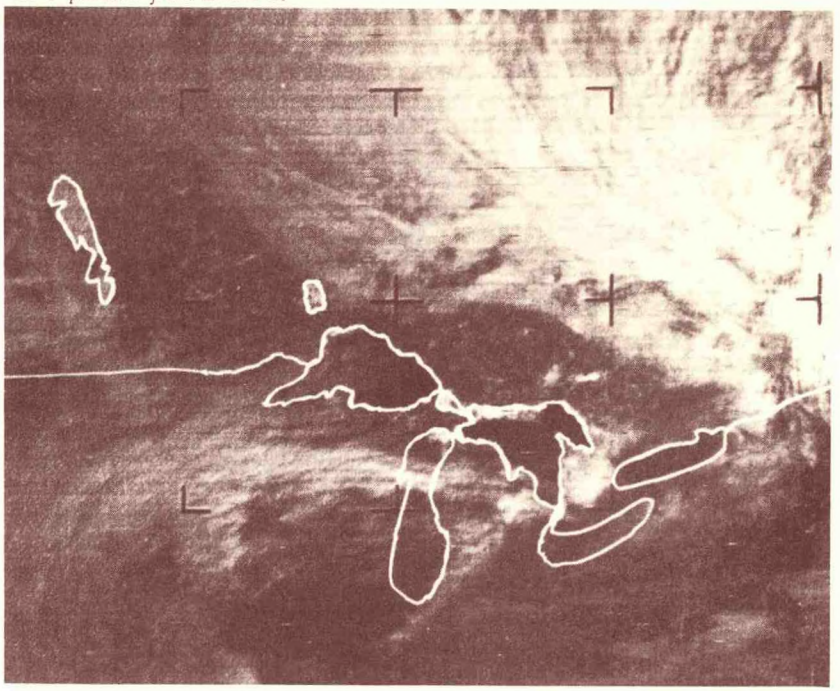
Albedo radiation provides measurements of energy levels in the visible and near-infrared (0.2 to 4 microns) range for computing the albedo of the earth and clouds.

Other experiments on Nimbus II included the Direct Readout Infrared Radiometer and a Data Code Grid experiment. The first provided a direct readout of HRIR at night using the APT channel which, with some modification, is compatible with the APT facsimile receiving equipment. The second provided for the inclusion of picture-time and location data as well as orbit information, all encoded along one edge of the APT picture to furnish the user directly with the necessary reference data. This technique may make it possible to eliminate or reduce the daily alert messages which are transmitted over meteorological teletypewriter networks to all parts of the world.

The HRIR and MRIR sensors aboard the Nimbus II have ceased operation, but only after having provided data essential to their evaluation.

On June 19, 1966, TIROS VII completed three years of successful operation and, as of November 1966, was still returning good-to-excellent pictures. Approximately 123,000 meteorologically usable pictures have been taken by this satellite; however, with the successful operation of TIROS IX, X, and ESSA 1, all in near-polar orbits, TIROS VII is programed on a minimum basis.

APT picture from ESSA 2.



ESSA 3, the first TOS System spacecraft with the Advanced Vidicon Camera System (AVCS) was launched successfully on October 2, 1966. This system, like the APT system on ESSA 2, uses two 1-inch vidicon cameras for redundancy and longer spacecraft life. The improved cameras, plus a near-polar orbit at an altitude of 892 miles, provide complete daily global picture coverage. ESSA 3 also carries a flat-plate radiometer to obtain heat-flux data for both long-wave and albedo radiation measurements.

NATIONAL OPERATIONAL METEOROLOGICAL SATELLITE (NOMS) SYSTEM

The Department of Commerce, on March 15, 1966, became the first civilian agency other than NASA to control an operational spacecraft system; control of the ESSA 2 APT spacecraft was transferred to the National Environmental Satellite Center (NESC) on that date. Control of the ESSA 1 and TIROS IX spacecraft was transferred to NESC on June 21 and ESSA 3 came under NESC control on October 14, 1966. The NOMS system operated by the

NESC includes an Operations Center at Suitland, Maryland, and Command and Data Acquisition (CDA) stations at Gilmore Creek, Alaska, and Wallops Station, Virginia. The Gilmore Creek CDA station is operated under contract with on-site management provided by an NESC station manager and a small staff. The Wallops CDA station is the first civilian satellite CDA station to be 100 percent staffed by Government rather than contract personnel.

The system is presently controlling TIROS IX, and ESSA 1, 2, and 3. TIROS IX is now passing through the daylight-darkness line; by early 1967, it will be far enough into sunlit areas to permit testing its camera systems to see how well it has survived this transition. ESSA 1 has had one camera failure, but is continuing to provide some useful picture coverage. ESSA 2 has had one transmitter and one decoder failure, but otherwise is functioning well. It is reaching an orbital time so early in the morning that in northern latitudes it is becoming too dark for effective photography; however, from the Equator to about 40 degrees North, it provides useful early morning cloud-cover information.

Excluding TIROS IX, each of the last three satellites in the TIROS series has one usable camera system remaining. NASA continues to monitor these satellites and to exercise them occasionally for engineering evaluation.

DATA APPLICATIONS

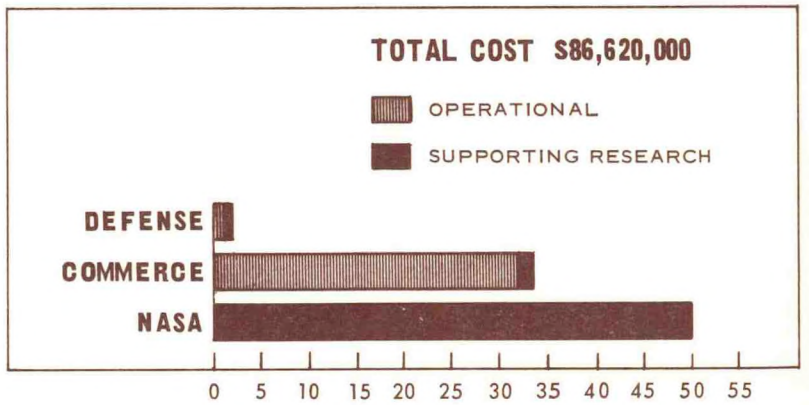
Thirty-six hurricanes and typhoons were observed and tracked during FY–66. Two of these storms were first discovered by satellite observation. From July 1961 through August 1966, 193 tropical storms were observed by satellites; 42 of these were first discovered by satellite observation. During FY–66, more than 400 special tropical storm advisories were sent to meteorological services around the world.

An experiment in computer processing of cloud pictures was begun when global data became available from ESSA 1. Pictures were digitized and converted to conventional weather-map scale for facsimile transmission to weather stations. Test transmissions were made to the National Hurricane Center at Miami, Florida, with excellent results.

With the advent of ESSA 3 data in October, computer processing of cloud pictures was started on a daily basis. Production includes two polar stereographic outputs (one for each hemisphere) and a mercator output covering the tropical latitudes. Facsimile test transmissions of the North Atlantic analysis are being made to the John F. Kennedy Airport in New York. The tropical analysis is sent to the National Hurricane Center at Miami, the Kennedy Space Center at Cape Kennedy and the Manned Space Craft Center in Houston. These are the first steps toward computer production of the bulk of the products for weather center and office uses which are now supplied by manually prepared cloud analyses.

During September 1966, camera failures on ESSA 1 and Nimbus II left the NESC without global picture coverage. During the period prior to the launch of ESSA 3, Nimbus II high-resolution infrared (HRIR) data were supplied by NASA on a real-time basis. The HRIR data permitted continuing daily cloud analyses until global picture coverage became available with the ESSA 3 launch. The value of the HRIR system, planned as an integral part of the improved TOS system in 1969 and thereafter, was thus clearly established.

DISTRIBUTION OF OPERATIONAL AND SUPPORTING RESEARCH WEATHER SATELLITE PROGRAM COSTS BY AGENCY, FY-68



OPERATIONAL PLAN

The Department of Commerce is charged with developing, operating, and improving a National Operational Meteorological Satellite System to meet the requirements of all Federal agencies. Three major objectives for the national system have been stated by the Department of Commerce:

- ***An operational system for viewing the atmosphere regularly and reliably on a global basis both day and night, with automatic picture transmissions to local ground stations within radio range of the satellite.***
- ***An operational system for continuous viewing of weather features and, secondarily, relaying meteorological data from buoys or free balloons to and between weather centers.***

Spiral antenna atop of APT van picks up signals from weather satellites.

- ***An operational system for sounding the atmosphere regularly and reliably on a global basis as quantitative inputs to numerical weather prediction activities.***

Since full attainment of these long-term objectives is not possible until the mid-1970's, the agencies have defined as interim objectives:

- ***Global picture coverage on a daily basis***
- ***Night-time coverage***
- ***Automatic Picture Transmissions***

The TIROS Operational Satellite (TOS) System meets the interim objectives for the national system. It provides for two spacecraft in orbit at all times to provide both stored worldwide data and locally transmitted cloud-cover pictures at least once daily. One spacecraft is equipped with advanced vidicon camera systems and its photographs are stored on board for subsequent transmission to Command and Data Acquisition stations at Gilmore Creek, Alaska, and at Wallops Island, Va. The data are relayed to the National Environmental Satellite Center for processing by computers and subsequent integration with other observations in the analysis and forecasting routines of both civil and military agencies. The Air Force Global Weather Central at Offutt AFB also receives and processes the data from the two Command and Data Acquisition stations to meet its specialized military requirements. The second spacecraft is equipped with automatic picture transmission cameras to provide local area pictures as the spacecraft passes within radio range of land and shipboard stations equipped to receive the satellite transmissions.

An improved version of the TOS System spacecraft will combine stored data and automatic picture transmissions in a single vehicle. The first of these satellites, designated TIROS M, is scheduled for launch late in FY–68. These improved spacecraft, representing the third generation of meteorological satellites, have several significant advantages over their predecessors. Since the spacecraft combines the stored data and automatic picture transmissions in a single vehicle, the basic objectives of the national system can be met with fewer launchings and lower total costs. In addition to cost benefits, the improved spacecraft also has several technical advantages. It provides night-time cloud-cover mapping and radiating surface temperature measuring capability, carries sensors for other than meteorological uses, and has considerable growth potential to allow new sensors to be added as they become available.

A long-term plan for the National Operational Meteorological Satellite System is being prepared by the Federal Coordinator for Meteorological Services and Supporting Research. It is intended to provide a statement of the Federal Government's objectives and plans over the next five years for use by governmental, academic, and industrial communities. The Federal Coordinator is supporting this work with a study to determine the most effective and efficient means of distributing weather satellite products of all types to the various users.

The Department of Commerce finances, manages, and operates the TOS System. NASA is responsible for development, procurement, launch, and initial check-out of the spacecraft in orbit. The Air Force and Navy operate facilities to receive pictures from spacecraft. Funding for each agency is shown by function in the adjoining table.

AGENCY OPERATIONAL WEATHER SATELLITE PROGRAM COSTS BY FUNCTION

	SPACECRAFT & LAUNCHING		COMMAND & DATA ACQUISITION		DATA PROCESSING		TECHNICAL MANAGEMENT & SUPPORT		TOTAL	
	1967	1968	1967	1968	1967	1968	1967	1968	1967	1968
AIR FORCE			250	258					250	258
COMMERCE	16,260	21,374	5,994	4,527	3,637	5,098	1,109	1,201	27,000	32,200
NAVY			826	831					826	831
TOTAL	16,260	21,374	7,070	5,616	3,637	5,098	1,109	1,201	28,076	33,289

SPACECRAFT AND LAUNCHING

Plans call for launching two stored data and two automatic picture transmission satellites in FY–68 if required to maintain the TOS System in full operation. These will be followed by the first improved, multi-purpose spacecraft, TIROS M, late in the year. Funding for FY–68 is planned to increase by $5,114,000.

COMMAND AND DATA ACQUISITION

The costs in this function are planned to decrease by $1,454,000 due primarily to costs relating to the establishing of operational facilities in prior years.

DATA PROCESSING

The National Environmental Satellite Center receives all stored data from the Command and Data Acquisition stations for computer processing. The center uses the Department of Commerce central computer, smaller computers, and highly developed manual techniques to convert observational data into forms suitable for immediate operational use in analysis and forecasting routines, and for subsequent research or climatological uses. The FY–68 costs for this function are planned to increase by $1,461,000 as night-time data are obtained from the TOS System spacecraft.

TECHNICAL MANAGEMENT AND SUPPORT

Technical Management and Support for the operational weather satellite program is provided by the National Environmental Satellite Center, and by NASA on a reimbursable basis. Plans for this function include preparation of a systems operating manual for the complex operations of the National Environmental Satellite Center and for analyses aimed at improving the cost effectiveness of the TOS System.

SUPPORTING RESEARCH

For FY–68, planned weather satellite research and development programs designed to improve meteorological services total $53,331,000 an increase of $15,847,000 over the FY–67 program. The long-range aims of the meteorological satellite research effort are to provide the technology and the data necessary for (a) a global weather analysis and forecasting system to meet national requirements, (b) improvement in local interpretation of current weather and forecasts, and (c) the meteorological research needed to increase knowledge of the atmosphere.

Much of the satellite and ground-based equipment has already been developed, but research and experimental studies are required to determine how equipment can be modified to improve its accuracy and efficiency and to determine if new sensors or techniques could improve the data-yield from satellites. Meteorological research of steadily increasing sophistication is being carried out for the purpose of supplementing existing meteorological techniques as well as for developing the unique potential of the satellite as a meteorological tool.

Supporting research in weather satellites is conducted by the National Aeronautics and Space Administration and the Departments of Commerce and Defense. The distribution of funding among the five categories of effort is shown in the accompanying chart.

SATELLITE FLIGHT PROJECTS

The major portion of the budgetary program for supporting research in weather satellites is allocated to satellite flight projects in the TIROS, Nimbus, and ATS (Advanced Technology Satellite) R&D programs. A large part of the increase in funding from FY–67 to FY–68 is due to the design, development and launch support of TIROS M and to the design, system definition and the procurement of hardware components for Nimbus D.

These programs are conducted entirely by NASA, with input in the form of statements of requirements, technological advancements, and systems evaluations from the Departments of Commerce and Defense. This single-manager system monitored by the interested agencies provides maximum coordination and minimum duplication while still providing an optimum development program. As this sub-section contains the bulk of the supporting research funds, it is apparent that the major portion of the total program benefits from this coordinated effort.

The TIROS and Nimbus programs, designed for the conduct of research and development of our National Operational Meteorological Satellite System, also serve the interests of international meteorological programs. The TIROS Operational Satellite System and its improvements will support the World Weather Watch and will constitute a major contribution of this country to the program.

The ATS program consists of five flights designed to develop useful technology common to several space applications and to test space concepts. In the meteorological area, the experiments in the ATS program consist of testing several improved cloud camera systems, VHF communications links, and data gathering from moving meteorological platforms.

SATELLITE DATA ANALYSIS AND APPLICATIONS

The satellite data analysis and applications program is conducted by NASA, Commerce, and Defense. These projects are generally directed toward solving mission-oriented problems of the investigating agencies and are designed to insure maximum utilization of the data acquired by the space vehicle. Progress in this area is made slowly, but it is a most productive effort. Continued emphasis and application of maximum available resources is strongly indicated.

Adaptation of satellite data to automatic analysis procedures is considered a major technical problem, but is receiving adequate effort for the present state of satellite technology.

SATELLITE INSTRUMENTS AND EXPERIMENTS

Research on satellite-borne instruments and experiments is designed to further the state of the science of gathering basic meteorological data by satellite. This program is being conducted entirely by the Department of Commerce and NASA, with plans to test the results of this program on future flights of the NASA-directed TIROS and Nimbus programs. Integration of the sensors or experiments into the TIROS/Nimbus spacecraft has required constant coordination between the developing agencies. This sub-section contains the projects which will provide the second-generation instrumentation for future meteorological satellites and warrants a continued high level of effort.

AGENCY SUPPORTING RESEARCH WEATHER SATELLITE PROGRAM COSTS BY FUNCTION

	SATELLITE FLIGHT PROJECTS		SATELLITE DATA ANALYSIS & APPLICATIONS		SATELLITE INSTRUMENTS & EXPERIMENTS		SPACECRAFT TECH. & ASSOC. GRD. EQUIPMENT		ADVANCED STUDIES		TOTAL	
	1967	1968	1967	1968	1967	1968	1967	1968	1967	1968	1967	1968
AIR FORCE			463	371							463	371
ARMY			50	50			50	30			100	80
COMMERCE			966	1,070	625	335			735	1,060	2,326	2,465
NASA	20,490	32,259	921	1,215	11,969	12,676	850	850		3,000	34,230	50,000
NAVY			215	215			150	200			365	415
TOTAL	20,490	32,259	2,615	2,921	12,594	13,011	1,050	1,080	735	4,060	37,484	53,331

The experimental sensor complement to be flown on the third R&D spacecraft (Nimbus B) in the second quarter of FY–68 has been determined. The MRIR and HRIR experiments flown on Nimbus II will be repeated to provide additional data and reference information for the new sensors. The new sensors, not previously flown, are:

- ***The Satellite Infrared Spectrometer funded by NASA and developed by ESSA, which will measure the earth's spectral radiances at a number of intervals in the carbon dioxide absorption band at 15 microns. A mathematical technique has been developed to infer the vertical temperature structure of the atmosphere from the measured radiation.***
- ***The Infrared Interferometer Spectrometer will scan the earth's spectral radiances in the 5-to-20-micron wavelength interval. The spectrum measured will be used to infer the vertical temperature structure of the atmosphere using mathematical techniques and to determine the characteristics of ozone and water vapor in the atmosphere.***
- ***The Image Dissector Camera System is a line-scan camera system with approximately the same resolution as the AVCS flown on Nimbus II, but capable of providing a continuous strip picture of the earth and cloud cover for the full length of the sunlit part of each orbit.***
- ***The Interrogation, Recording and Location System in this experiment will make twice-daily collections of data relating to the surface of the earth and the atmosphere from fixed and free-floating platforms. The satellite will locate the platforms and record and store the data from the platforms for readout at the Command and Data Acquisition stations.***
- ***The Monitor of Ultraviolet Solar Energy will sense the ultraviolet solar flux in five spectral intervals and the time variations in the flux. The flux and its variations will be correlated to changes in the state and structure of the upper atmosphere.***

This research is closely related to the technological development effort the World Weather Watch and, in fact, can be directly compared with the requirements for improved sensors for both national and international uses. It will provide the sensory equipment necessary for improved observation of weather parameters on a global basis.

Determination of high-resolution vertical and horizontal distribution of atmospheric parameters from satellite altitude constitutes a difficult technical problem which will require considerable time and effort to solve.

SPACECRAFT TECHNOLOGY AND ASSOCIATED GROUND EQUIPMENT

Spacecraft technology and associated ground equipment is divided into the efforts conducted by NASA to improve the technology of spacecraft-associated instrumentation and by the Department of Defense to develop ground equipment. The NASA efforts are coordinated with inputs from the Departments of Commerce and Defense. The Defense programs seek to develop ground terminal equipments suitable for the peculiar operating environment of military forces.

The spacecraft technology portion of this program will provide improvements to the spacecraft employed to serve the national as well as international weather satellite programs.

The effort is essentially the same in FY–68 as in FY–67.

ADVANCED STUDIES

The advanced studies sub-section contains those projects conducted by the Department of Commerce which will contribute to a better understanding of the atmosphere from a space viewpoint or to the improvement of satellite-borne sensors. It also includes the NASA projects on advanced meteorological satellite spacecraft. These projects are exploratory and are intended to extend the state of the science well beyond the present-day capability. The NASA increase is largely due to work planned on Nimbus E and F. A DOC increase from FY–67 to FY–68 is attributable to advanced instrumentation design for satellite packages, and to design of a sounding balloon system for remote sensing by satellite.

This program can be clearly identified with the goals of the World Weather Watch. It will provide the most significant advances in the state of weather satellite technology toward establishment of an extensive global weather observing system.

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